THESIS

TAXONOMIC STUDIES ON THE NEMATODES OF INSECTS OF MANIPUR AND ADJOINING AREAS

ABSTRACT

THESIS

SUBMITTED FOR THE AWARD OF THE DEGREE OF

Doctor of Philosophy

IN

ZOOLOGY

BY

MD. MANJUR SHAH

DEPARTMENT OF ZOOLOGY
ALIGARH MUSLIM UNIVERSITY
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THESIS

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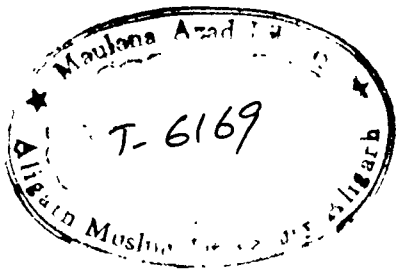

17 AUG 2006

The thesis deals mainly with the systematics of nematodes of insects of the state of Manipur and adjoining areas. Surveys were conducted of insects from August,1999 to January, 2002 for the parasitic infection by the members of the nematode superfamily Thelastomatoidea. The investigation of parasitic infection in the various insect hosts revealed that 4 families of the superfamily Thelastomatoidea viz., Thelastomatidae Travassos, 1929, Travassosinematidae Rao, 1958, Pseudonymidae Kloss, 1958 and Protrelloididae Chitwood,1932 generally parasitize them. Keys to the genera of these four families have been provided.

The members of the above four families are ususally parasitise three host insects viz., *Gryllotalpa africana*, *Periplaneta americana* and *Hydrophilus triangularis* in the North Eastern Part of India. Parasitism by the members of the superfamily Thelastomatoidea revealed that 15 species of nematodes were present. The nematodes belonged to 11 known genera, 6 new species and 9 known species, all of which are reported for the first time from North East India. In addition, the diagnoses of 10 genera have been emended. Identification keys to the species of 8 genera have also been provided with modification except for the genus *Pseudonymus* which is provided here for the first time. Comparative measurement charts of new as well as known species of 8 genera have also been provided.

1. The genera identified are:

    1. *Binema* Travassos, 1925
    2. *Cameronia* Basir, 1948
    3. *Chitwoodiella* Basir, 1948
    4. *Gryllophila* Basir, 1942
    5. *Hammerschmidtiella* Chitwood, 1932
    6. *Leidynema* Schwenk in Travassos, 1929
    7. *Mirzaiella* Basir,1942
    8. *Protrellus* Cobb, 1920
    9. *Pseudonymus* Diesing, 1857
    10. *Zonothrix* Todd,1942
    11. *Thelastoma* Leidy,1849

2. The new species are:

    1. *Cameronia triovata* n.sp.
    2. *Cameronia manipurensis* n.sp.
    3. *Binema anulinervus* n.sp.
    4. *Pseudonymus basiri* n.sp.
    5. *Protrellus shamimi* n.sp.
    6. *Zonothrix imphali* n.sp.

3. The known species are:

1. *Binema mirzaia* Basir,1942
2. *Binema korsakowi* Sergiev,1923
3. *Binema ornata* Travassos,1925
4. *Chitwoodiella ovofilamenta* Basir,1948
5. *Gryllophila skrjabini* Sergiev,1923
6. *Hammerschmidtiella diesingi* Hammerschmidt, 1838
7. *Leidynema appendiculatum* Leidy,1850
8. *Mirzaiella asiatica* Basir,1942
9. *Thelastoma periplaneticola* Leibersperger,1960

4. Family-wise distribution of nematodes:

a. The family Thelastomatidae is represented by 6 species of nematodes under 5 genera, i.e., *Thelastoma periplaneticola* Leibersperger,1960; *Cameronia triovata* n.sp.; *C. manipurensis* n.sp.; *Gryllophila skrjabini* Sergiev,1923; *Hammerschmidtiella diesingi* Hammerschmidt,1838; *Leidynema appendiculatum* Leidy,1850.

b. The family Travassosinematidae is also represented by 6 species of nematodes belonging to 3 genera, i.e., *Binema ornata* Travassos,1925; *B. mirzaia* Basir,1942; *B. korsakowi* Sergiev,1923; *B. anulinervus* n.sp.; *Mirzaiella asiatica* Basir,1942; *Chitwoodiella ovofilamenta* Basir,1948.

c. The family Pseudonymidae is represented by 2 species of nematodes under 2 genera, i.e., *Pseudonymus basiri* n.sp., *Zonothrix imphali* n.sp.

d. The family Protrelloididae is represented by a single species of nematode namley *Protrellus shamimi* n.sp.

5. First record from North East India:

1. *Binema mirzaia* Basir, 1942
2. *Binema korsakowi* Sergiev,1923
3. *Binema ornata* Travassos,1925
4. *Chitwoodiella ovofilamenta* Basir,1948
5. *Gryllophila skrjabini* Sergiev,1923
6. *Hammerschmidtiella diesingi* Hammerschmidt,1838
7. *Leidynema appendiculatum* Leidy, 1850
8. *Mirzaiella asiatica* Basir, 1942
9. *Thelastoma periplaneticola* Leibersperger,1960

6. Generic diagnosis emended are:

1. *Thelastoma* Leidy, 1849
2. *Gryllophila*, Basir,1942
3. *Cameronia* Basir,1948
4. *Binema* Travassos,1925
5. *Leidynema* Schwenk in Travassos,1929
6. *Chitwoodiella* Basir,1948

7. *Pseudonymus* Diesing,1857
8. *Zonothrix* Todd,1942
9. *Protrellus* Cobb,1920
10. *Hammerschmidtiella* Chitwood,1932

7. Key to the genera of the following families have been provided for the first time.

a) Thelastomatidae Travassos, 1929
b) Travassosinematidae Rao,1958
c) Pseudonymidae Kloss,1958
d) Protrelloididae Chitwood,1932

8. Key to the species of the following genera have been provided (after modification)

a) *Leidynema* Schwenk (in Travassos, 1929)
b) *Gryllophila* Basir,1942
c) *Cameronia* Basir,1948
d) *Chitwoodiella* Basir,1948
e) *Binema* Travassos,1925
f) *Mirzaiella* Basir,1942
g) *Zonothrix* Todd,1942
h) *Protrellus* Cobb,1920

8. Key to the species of the genus *Pseudonymus* Diesing, 1857 have been provided for the first time.

9. Comparative measurement charts of the species of the following genera have been provided.

a) *Leidynema* Schwenk in Travassos,1929

b) *Gryllophila* Basir,1942

c) *Cameronia* Basir,1948

d) *Chitwoodiella* Basir,1948

e) *Binema* Travassos,1925

f) *Mirzaiella* Basir,1942

g) *Pseudonymus* Diesing,1857

h) *Protrellus* Cobb,1920

10. Mole cricket (*Gryllotalpa africana*) harboured 5 genera and 9 species out of which 3 are new and have been described in the present work. American cockroach (*Periplaneta americana*) harboured 4 genera and 4 species out of which one species is new to science. Aquatic beetle (*Hydrophilus triangularis*) harboured two new species belonging to the genera *Pseudonymus* and *Zonothrix* respectively.

Lastly, among the three hosts, worm burden has been found to be the highest in *H. triangularis* , *G. africana* stands next and *P. americana* the last.

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TO
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CERTIFICATE

This is to certify that the entire research work that has been presented in the thesis entitled **" *Taxonomic studies on the nematodes of insects of Manipur and adjoining areas*"** *by* ***Mr. Md. Manjur Shah*** *is original and carried out by the candidate himself under my supervision. I have allowed* ***Mr. Shah*** *to submit it to the Aligarh Muslim University in fulfilment of the requirements for the degree of* ***Doctor of Philosophy in Zoology***.

Prof. Durdana S. Jairajpuri
Supervisor

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19/9/03

Md. Manjur Shah

CONTENTS

2. *Chapter - II*

3. *Chapter - III*

4. *Chapter - IV*

INTRODUCTION AND HISTORICAL REVIEW

Manipur is situated in the north east of India. The state covers an area of 22,356 sq.kms of which the hilly region is about 91.75%, while the remaining 8.25% of the geographical area constitutes the central valley region. It lies between $23^0$51`N and $25^0$41`N latitudes and $93^0$2`E to $94^0$47`E longitudes. Generally, two types of climatic conditions are found in this state according to latitude, topography and direction of the prevailing wind system. Tropical monsoon type of climate prevails in the valley area whereas the cool temperate climate prevails in the hilly areas. The average maximum temperature of this state is 31^0C, the minimum temperature is 5^0C and the rainfall is about 2077mm per annum. The type of soil found in the hilly area is red, stony, gravely or heavy soil with a soil pH ranging from 5-6, i.e. acidic in nature and in the plain areas, it ranges from sandy loam to clayey loam with soil pH varying from 6.5-8.1. According to 1991 census, the total population of state is 18,37,149. Out of the total population nearly two-thirds are concentrated in the valley proper and about one third is spread over the surrounding hills.

The thesis mainly concerns with taxonomic study on the nematodes of insects of Manipur and its adjoining areas. This is for the first time that such a study has been carried out in the state.

Nematodes are regarded as the most numerous multicellular animals on earth. A handful of soil will contain thousands of microscopic worms, many of them would be parasites of insects, plants or animal. Free living species are

abundant including nematodes that feed on bacteria, fungi and other nematodes, yet the vast majority of species encountered are poorly understood. There are over 20,000 described species classified in the phylum Nematoda.

Most of the free-living nematodes are microscopic, many of the parasitic species invade the body fluids such as blood or lymph channels of their hosts. They exhibit a wide range of feeding habits. Many feed entirely on the microorganisms present in decaying vegetable matter (saprophytic), others live on plants and wander destructively through the tissues and suck their sap. In vertebrates they may parasitize every organ often causing destructive and painful diseases and producing immeasurable hardships. Their life cycle ranges from very simple to extremely complicated.

The majority of the nematodes are oviparous, but some are ovoviviparous. All nematode juveniles whether they hatch in water or soil or within the animal host must undergo a series of 4 moults before reaching maturity.

Entomophilic or insect nematodes are distributed in 27 families among nine major groups of nematodes viz., Rhabditoid, Tylenchoid, Aphelenchoid, Strongyloid, Oxyuroid, Ascaridoid, Spiruroid, Filaroid and Mermithoid.

The first eight groups belong to the Secernentea (or Phasmidia which are plant and animal parasitic form) and the 9th belong to the Adenophorea (or Aphasmidia which are mostly free living, microbotrophic aquatic nematodes), the two primary taxonomic divisions of the Nematoda (Chitwood, 1933; Nickle &

Welch, 1984). However, Adamson (1987a) proposed the Class Enoplea instead of Adenophorea and Rhabditea for Secernentea. Herein, we also follow his classification. The present thesis is mainly concerned with the Order Oxyurida that parasitize both invertebrate and vertebrate hosts. The nematodes parasitizing the vertebrate hosts belong to the superfamily Oxyuroidea and those nematodes parasitizing the invertebrate hosts belong to the superfamily Thelastomatoidea. The families listed under the latter superfamily are Thelastomatidae, Travassosinematidae, Protrelloididae, Hystrignathidae and Pseudonymidae. With the discovery of haplodiploid reproduction (Adamson, 1984) in this group of nematodes in which males develop from unfertilized eggs (haploid) and females from fertilized eggs (diploid) more attention is being paid to the above group of nematodes in the recent time.

Entomophilic nematodes vary greatly in size and shape, have insects as intermediate or as definitive hosts, may be facultative or obligatory in their host relations and often involve other microorganisms in their relationships with their hosts.

Though there are no report on important pathogens of man or domestic animals in these groups, entomophilic nematodes cause debilitation, sterility (partial/complete) or death of a large number of insects belonging to various Orders and families. They have evolved to parasitize every kind of insects , so it is not too surprising to find them killing, sterilizing or otherwise debilitating millions

of different kinds of insects such as mosquitoes, blackflies, chironomid flies, grasshoppers, moths, ants, bees and many other insects and invertebrates.

The life cycles of various parasitic nematodes were worked out during the period 1820-1870. Hammerschmidt (1838) first gave the complete description of an insect parasitic oxyurid. Leidy (1849,1850,1853) erected a new genus *Thelastoma*. In 1851 Diesing (1800-1867) published " Systema Helminthum" with 175 insect nematode records involving five entomophilic genera. Cobb (1898,1920,1927,1929) described many new genera and species and stressed the potential of nematodes in controlling insect pests. Hagmeir (1912) made the first extensive revision of the family Mermithidae. Glasser (1931,1932) was the first to speculate on the potential of *Neoaplectana* for the biological control insect pests and gave much importance to mass-culture techniques. He was the first researcher to culture *N. glaseri*. Christie (1931,1938) worked on nematode parasites of coleopteran larvae. Chitwood (1932) published a synopsis of nematodes parasitic in insects and described many new species of thelastomatid nematodes. Filipjev (1934a) should certainly be named the father of Insect Nematology. He contributed extensively through his work on nematode classification, brought together the scattered information on insect nematodes and incorporated his own findings into the synthesis. This formed second section of a monograph published in Russian in 1934 entitled "Nematodes that are harmful but useful in Agriculture". Chitwood & Chitwood (1934) described a new species *Thelastoma*

palmettum and some known species of thelastomatid nematodes. Basir (1940-1956) reported 9 new and 79 known species of the superfamily Thelastomatoidea covering 30 genera. His contributions have been a great inspiration to the Indian workers and a rapid series of publications followed afterwards. Chakravarty (1943) described a new genus *Indiana* from *Gryllotalpa africana* (mole cricket). Todd (1943) first reported the male of *Thelastoma icemi*. Goodey, T.(1951) and Goodey, J.B.(1963) published books on systematic containing nematodes associated with insects. Dollfus (1952,1964) worked on oxyurids of myriapodes and described 2 species of *Thelastoma*. Singh (1955) recorded two new species of the genera *Rhigonema* and *Thelastoma* from a millipede host. Theodorites (1955,1956) worked on nematodes of coleopteran and diplopods. Ruhm (1956) did very valuable work on the taxonomy of nematodes of bark beetles and has described one new family, 2 new subfamilies, five new genera, seven new subgenera, 78 new species and four new subspecies. Singh & Singh (1958) described five new species from *P. americana* and *Gryllotalpa africana* from North India. Rao (1958) dealt with a number of nematode parasites of insects and other arthropods from Hyderabad, South India and reported 6 new genera, 9 new species and 14 known species representing twenty genera. Kloss (1959 a, b, c, d; 1965) described many new species. Welch (1959) studied the rather complicated taxonomy and life cycle of *Parasitylenchus diplogenus* on fruit flies of the genus *Drosophila*. Leibersperger (`1960) described many new species of Thelastomatid

nematodes. Fotedar (1964) described a new species of *Pseudonymus* from aquatic beetle in Kashmir. Rao & Rao (1965a,b,c,d;1966, 1981) described 7 new species belonging to genera viz., *Corydiella*, *Blattophila*, *Hammerschmidtiella*, *Cephalobium*, *Blatticola* and *Schwenkiella* and *Mehdinema*. Skrjabin *et al.*, 1966b published work on oxyurids of invertebrates and modified the work of earlier workers. Farooqui (1967; 1968a,b, c, d, e; 1970) published description of twenty one new species and four known species representing seventeen genera of the family Thelastomatidae.. He also established a new family Mehdinematidae and described the male of *Thelastoma spicatum* previously not known. He synonymised *Hammerschmidtiella spicatum* and *Leidynema stylopygi* of Biswas & Chakravarty,1963 with *H. diesingi* and *L. appendiculata* respectively. Nickle (1967a) studied the taxonomy of Sphaerulariidae based on the representatives of the 15 of the 22 genera and presented a classification system this family. Kumari (1967) described a new species of the genus *Johnstonia*. Dale (1967) studied the dispersal and phylogeny of some oxyurid nematodes. Taylor (1968) reported that *Leidynema appendiculatum* (Thelastomatidae) caused lesions in the hindgut of *Leucophaea maderae* which apparently were initiated as tissue damage followed by a hemocytic response and melanization on the part of the host. Nadakal and Nayar (1968) studied the neural and hormonal influence on the fecundity and egg laying of Oxyurid nematodes inhabiting the hindgut of the cockroach, *P. americana*. Lal (1968) described a new species of the genus *Klossinema* from a

coleopteran insect. Jarry & Jarry (1968) worked on insect nematodes and distinguished between the relative genera of thelastomatid nematodes. Waerebeke (1969b,1970,1973,1987) had done elaborate work on insect nematodes. Ali & Farooqui (1969) reported a new genus *Cordonicola* and a new family *Cordonicolidae* from black roach *Blaberus* sp. Ipatyeva(1970), provided a list of nematodes associated with the Scarabaeoidea. Later Majumdar (1970) reported that *L. appendiculatum* infection in larval and adult *P. americana* caused total lipid reduction. Besides this, the dietary intake of the insect host influences the type of nematode infection (Hominick & Davey, 1972b). Peregrine (1974 a, b) observed that starved cockroaches showed a lower burden of nematode infection. Rubtsov (1971,1974) from Leningrad had described over 20 new genera and dozens of new species. Rao(1973) worked on nematode parasites of millipedes and described a new species. Poinar (1973,1977a, 1978) described several new species of thelastomatid nematodes. Lee (1974) published work on the occurrence of dimorphic males in *Thelastoma attenuatum*. Massey (1974) produced a monograph on the taxonomy of nematodes of bark beetle in the United States. Tewarson & Gupta (1976) synonymised the genus *Schwenkiella* with *Thelastoma*. Anuar & Paran (1977) worked on the parasites of *P. americana* in Penang, Malaysia and described a new species of thelastomatid nematode. Clark (1978) reported a new species of thelastomatid and rhigonematid nematodes from millipedes. Gupta & Kaur (1978) described new host and localities for several

insect nematode species. Parveen & Jairajpuri (1980,1981,1982,1984a,b;1985a,b) have worked on the taxonomy of nematodes of arthropods and reported 12 new and 11 known species representing one new and 14 known genera from North India, such as *Thelastoma*, *Isobinema dimorphicaudatum*, *Chitwoodiella neoformes*, *Cameronia klossi*, *Binema parva*, *Psilocephala nisari*. Gupta & Lamba (1981) worked on nematode parasites of arthropods from Chandigarh. Upton *et al.*, (1983) described a new species of thelastomatid from the desert millipedes. Sharma & Gupta (1983a,b) described a new species, *Protrellatus striati* from *Gryllus domesticus* and a new species of *Hammerschmidtiella* from Bareilly, North India. Spiridonov (1984) has introduced new taxonomic characters in oxyurid parasites of arthropods. Adamson (1985; 1987a,b) described several new species of thelastomatid nematodes. Bowie(1985) also described a new species of nematode from millipedes. Ahmad *et al.* (1986) reported a new species of nematode parasitizing arthropod from Maharashtra. Singh (1987) added a new species from *Periplaneta americana*, from Meerut, North India. Singh & Kaur (1988) described *Hammerschmidtiella basiri* from *Periplaneta americana*. Duggal & Aulakh (1988) worked on nematode parasites infecting household insects in North-West India. Mathur & Khera (1989) studied the influence of host stage and sex upon the size and composition of the nematodes parasitic in *Periplaneta americana*. Salmanov *et al.*, 1989 worked on the nematodes of *Gryllotalpa gryllotalpa* and described six species of entomophilic nematodes. Waerebeke &

Adamson (1992a) revised the nematodes of the family Thelastomatidae. Adamson & Noble (1992) worked on the structure of Oxyurid nematodes in American cockroaches. Renapurkar & Gosavi (1992) reported the effects of multiple species infection of nematodes in *Periplaneta americana* from Bombay (Maharashtra). Indian workers in the field of Insect Nematology paid more importance only during the last fifty years. Mojumdar & Khan (1992) reported one new species of the family Thelastomatidae and provided information on the thelastomatid nematode parasitism in the hindgut of *Periplaneta americana*. Hunt (1993) described two new species of nematodes from Sulawesi and Papua New Guinea. Rizvi & Jairajpuri ((1995) performed Scanning electron microscopy on the nematode parasites of insects for the first time in India. They (1997b) did SEM studies on some *Thelastoma* spp. collected from the cockroach, *Periplaneta americana*. Rizvi *et al.* (1997), Rizvi & Jairajpuri (2000 a, b) provided information on the oogenesis and gametogenesis in thelastomatid nematodes. Singh & Agarwal (1997,1998) gave information on the *Hammerschmidtiella diesingi* with a note on the early embryonic development and validity of various species of the genus and described a new species, *Schwenkiella orientalis* from *P. americana*. Rizvi *et al.* (1998) described a new species of the family Travassosinematidae from a mole cricket with SEM observations on *Leidynema appendiculatum* of the family Thelastomatidae. Camino & Reboredo (1999, 2001) described two new species of nematode, from the mole cricket from Argentina. Rizvi *et al.*, (2002)

described two new species of the families Thelastomatidae and Protrelloididae respectively.

The entire thesis is divided into two parts: Part-1 deals with the epidemiological studies and the Part-2 deals with the taxonomy of nematodes of the Superfamily Thelastomatoidea (Order:Oxyurida). Historical review of the superfamily, four families and various genera are provided at the beginning of each chapter. Identification keys of species most of the genera and comparative measurement charts of new species are also provided.

Many species of insects were examined but only few species were found to harbour nematodes of the superfamily Thelastomatoidea. The nematodes recovered were found to represent four families viz., Thelastomatidae, Travassosinematidae, Pseudonymidae and Protrelloididae. The Part-2 of the thesis is divided into 4 Chapters. The first chapter deals with the family Thelastomatidae, the 2nd chapter with the family Travassosinematidae, the 3rd with family Pseudonymidae and the 4th with the family Protelloididae. Total number of species described are 15, representing 4 families, 11 known genera, 6 new species and 9 known species. All the known and new species are reported for the first time from North East India. The range, mean, standard deviation of mean and De Man's ratio have been calculated and provided for all the species that have been described.

PART - I
EPIDEMIOLOGICAL STUDIES

Introduction

A comparative study on prevalence as well as seasonal variation on prevalence of insect nematodes of Manipur was carried out at three different time periods viz., August - October, 1999; September - November, 2000 and November, 2001 - January, 2002. The insect hosts selected for study are *Periplaneta americana*, *Gryllotalpa africana* and *Hydrophilus triangularis*.

Material and methods

The insect host were dissected and the gut was removed. The gut was then teased in normal saline. The contents were allowed to settle down for sometime. The nematodes collected from insect hosts were transferred to cavity blocks during which the number of nematodes collected on that particular day corresponding to the no. of host dissected was noted down. Then the nematodes were killed and fixed in TAF (Triethanolamine formalin) fixative. The fixed nematodes were kept for further processing for taxonomic studies.

Average (±S.D.) is calculated as mean value of individual observation / total no. of observations, where individual observation is the number of parasites found / total number of hosts dissected on that particular day. The Tabulated data for individual observations has been excluded herein.

Results

1. During August-October, average nematode infection was found highest in *H. triangularis* followed by next *G. africana* and least *P. americana* (Fig.2)
2. During September-November, average nematode infection was highest in *G. africana*, followed by *H. triangularis* stands the next, and *P. americana* being the least(Fig.4).
3. During November-January, average nematode infection was highest in *G. africana*, *H. triangularis* the next and the *P. americana* the least of three (Fig.6).
4. In three seasons, *P. americana* was found to be least infected.
5. A comparative account on prevalence of nematodes in insect host has been presented in Figs.1, 3 and 5.
6. Based on the statistical data mentioned in Table-I, it has been found that prevalence (% infection) and average nematode infection/host was found to be highest during September-November and lowest in November-January for *P. americana* and *H. triangularis* (Figs. 7 & 8). For *G. africana* the period September-November has the highest and August – October the lowest, both in terms of % infection and average parasitic burden (Figs. 7 & 8). Maximum infection was observed during September-November and

minimum during November-January for all the three insect hosts irrespective of sex, size or stage of the nematode.

Discussion

1. The distribution of entomophilic nematodes is not continuous throughout the area of distribution of host (Welch, 1963); consequently distribution of nematodes per host (e.g., rate of incidence of infection) departs from the prevalence (e.g., percentage dominance) of the species in the total worm burden of the host population.

2. Development or survival of eggs outside the host is influenced by many factors like temperature, moisture, oxygen supply, etc. These factors are optimum during the period September-November due to which there is maximum parasitic burden in the 3 insect hosts, i.e., *P. americana, G. africana* and *H. triangularis.*

3. However, despite variations due to environmental factors, there are also other factors which contribute to population fluctuations. Among them, host diet appears to significantly affect the development of nematodes, e.g. starved cockroaches have lowest nematode burden (Peregrine, 1974a), and egg production by nematodes is reported to diminish (Nadakal and Nayar, 1968) or to increase (Peregrine, 1974a). A probable explanation for the effects of host diet on nematode numbers is that it alters the

composition of the bacterial population on which these nematode feeds in the host hindgut (Peregrine, 1974a). There are also reports on the relationship between cockroach hosts hormonal system and nematode parasite population. Peregrine (1974b) found that significantly large number of *T. attenuatum* and *H. diesingi* occurred in the host fed on normal diet in comparison to those fed on artificial diet.

4. According to Welch (1963) intraspecific competition generally results in decrease in parasitic size with an increase in parasitic number. Regulation of nematodes must also be considered at the individual host level. It can either be due to host mortality induced by the parasite or to the emergence of directly dependant regulations at the parasite infra population level (Keymer, 1982).

5. In all the nematodes collected, females outnumbered the males. The mechanism of limiting males could be the result of an ESS (Evolutionary Stable Energy), related to the haplodiploidy in these groups (Adamson, 1989, 1990), which could evaluate the number of males needed to inseminate all females according to Hamilton's theory (1967). This reproduction mechanism (haplodiploidy) in which males develop from unfertilized eggs (haploid) and females from fertilized eggs (diploid)

must have had some effects on the population dynamics of the insect nematodes.

6. Hominick and Davey (1972a) suggested that host nutrition might play an important role in differences in parasitism of male and female nematodes and though all stages of the host partake food from the same source, quantitative and qualitative differences in food intake could exist.

TABLE – I

Frequency of Nematode infection in three different insect hosts in three seasons

Seasons	August-October,1999					September-November, 2000					November, 2001-January, 2002				
Host	No.of obs.	Total Host	Total Parasite	Average (±S.D.)	% Infection	No.of obs.	Total Host	Total Parasite	Average (±S.D.)	% Infection	No.of obs.	Total Host	Total Parasite	Average (±S.D.)	% Infection
Periplaneta americana	30	223	1793	8±3	807	40	154	1315	7.08±5.22	853	6	91	293	3.32±1.92	321
Gryllotalpa africana	36	352	2971	9±4	844	11	111	1336	11.8±77.4	1203	8	186	1881	9.4±2.1	1011
Hydrophilus triangularis	8	164	1831	19±14	1116	4	19	239	9.78±6.42	1257	1	1	7	7	700

S.D. = Standard Deviation

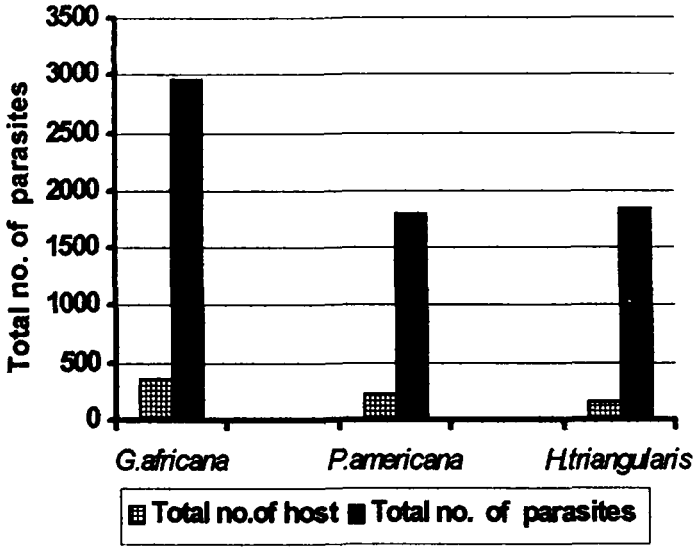


Fig.1 Prevalence of insect nematode during the period August-October

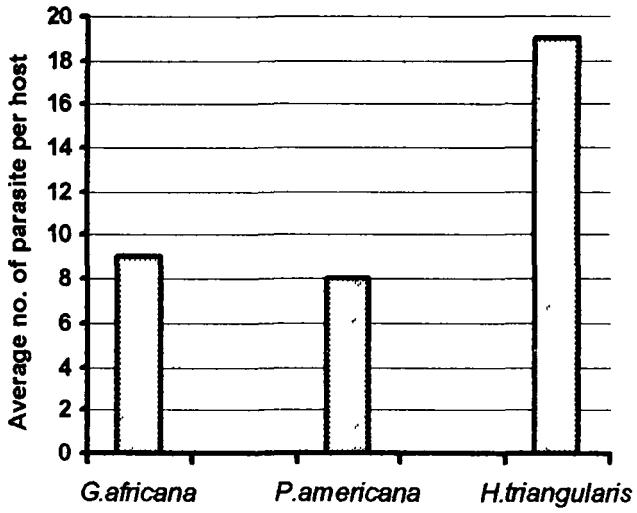


Fig. 2 Average nematode infection per host

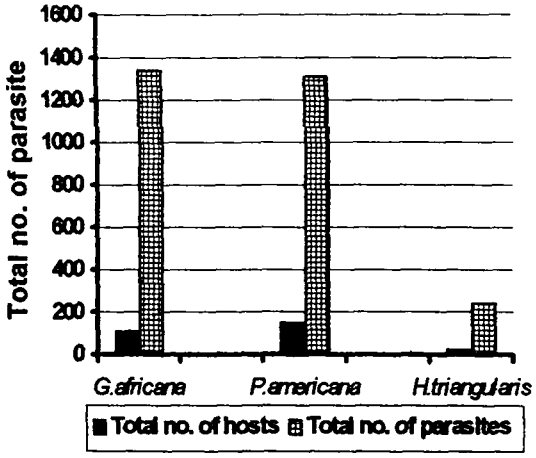


Fig.3 Prevalence of insect nematode during the period September-November

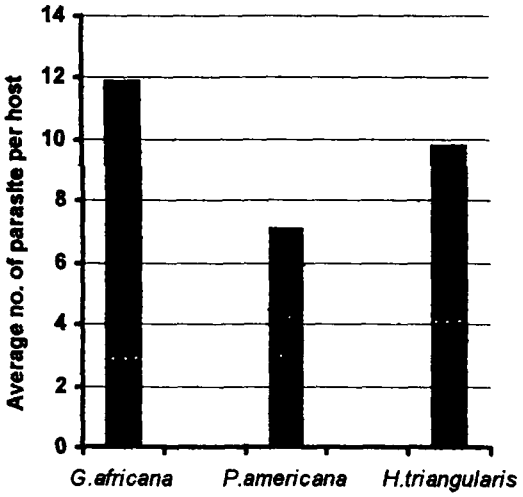


Fig.4 Average nematode infection per host

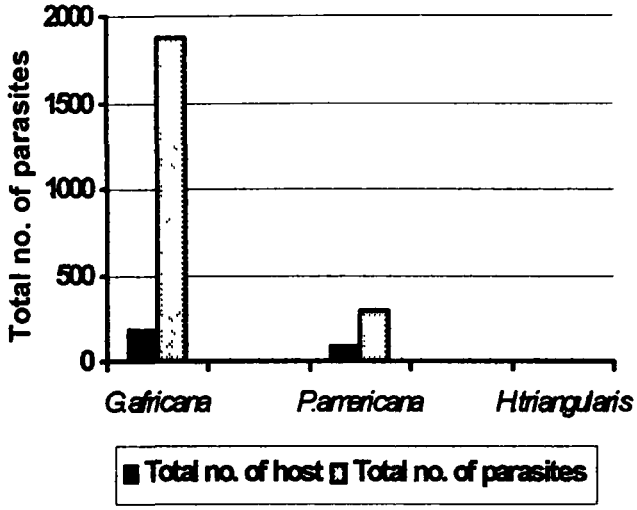


Fig. 5 Prevalence of insect nematodes during the period November - January

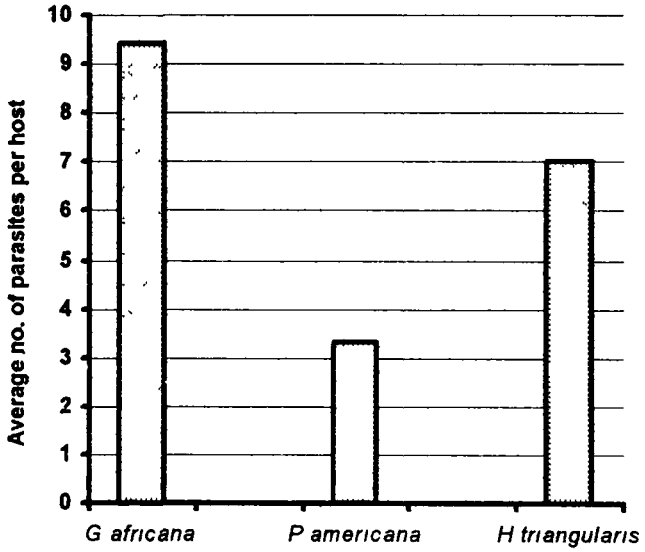


Fig.6 Average nematode infection per host

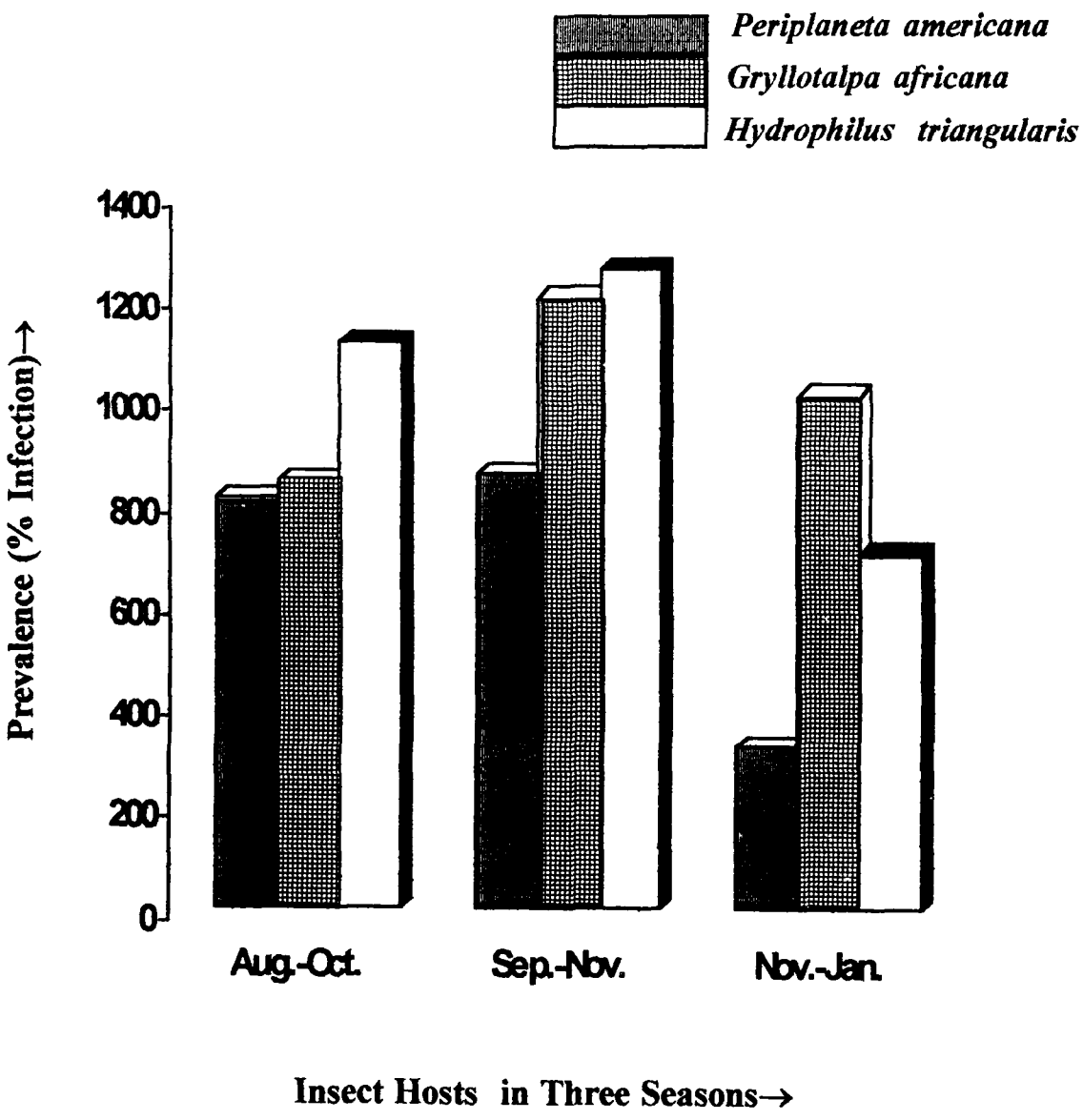


Fig. 7 Prevalence (% infection) of three insect hosts in three seasons

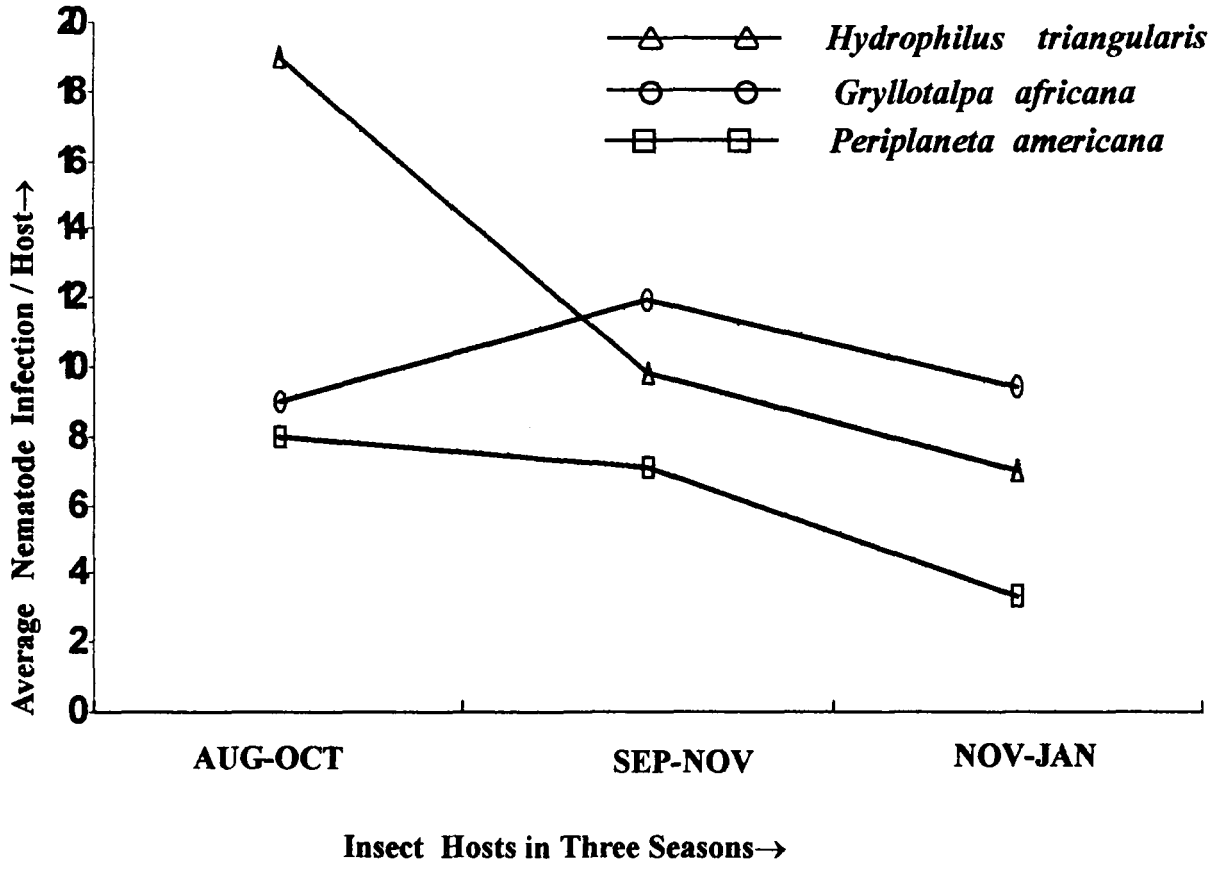


Fig. 8 Average nematode infection per insect host in three seasons

PART - II
TAXONOMIC STUDIES

Material and Methods

Material and methods

1. Collection of the host

The insect hosts namely, *Periplaneta americana*, *Gryllotalpa africana* and *Hydrophilus triangularis* were collected regularly from different districts of Manipur during the periods August-October,1999, September- October,2000 and November- January, 2002.

2. Collection and isolation of nematodes

The insect hosts were anaesthetized with chloroform and dissected immediately in normal saline. The intestine was removed and transferred to a petridish. The alimentary canal was teased out and the contents were mixed with saline. The petridish was kept undisturbed for a few minutes allowing the contents to settle down at the bottom. The insect nematodes are usually easily spotted by the naked eyes due to their size and movement. However, small sized nematodes were picked with the help of a needle under the low power stereoscopic binocular microscope. The nematodes were then transferred to cavity blocks containing normal saline. A preliminary examination under the binocular microscope was carried out in order to study their activity, movement, colour and certain morphological details which cannot be observed after fixation.

Normal saline for invertebrates was prepared as follows:

NaCl - 7.0g

KCl - 0.3g

$CaCl_2$ - 0.1g

$NaHCO_3$ - 1.5g

$MgSO_4$ - 0.3g

The above salts were dissolved in 1 litre of distilled water

3. Killing and fixation of nematode

The nematodes in normal saline were allowed to relax for 2-3 hours and then the saline was removed with the help of a dropper. The nematodes were then killed and fixed with hot TAF (Triethanol amine formalin) fixative (Courtney *et al.*, 1955).

TAF was prepared by mixing the following:

Triethanol amine - 2ml

Formalin - 7ml

Distilled water - 91ml

TAF was boiled in a beaker and then poured over the nematodes kept in cavity blocks. The nematodes were then transferred to screw capped Borosil tubes containing TAF. The edges of the tubes were sealed using paraffin wax and then wrapped with paraffin film in order to avoid leakage. The fixed nematodes were then brought to the laboratory for further processing.

4. Dehydration, mounting and sealing

For gradual dehydration, fixed nematodes were transferred to glycerin-alcohol (5 parts glycerine and 95 parts 30% alcohol) and placed in dessicator

containing anhydrous calcium chloride as a dehydrating medium at room temperature for about 2-3 weeks. During this period the alcohol evaporated leaving the nematodes in pure glycerine.

The dehydrated nematodes were then mounted on glass slides in anhydrous glycerine. Glass wool or wire of suitable thickness was used to avoid flattening or crushing of the nematodes. Lactophenol was used as a quick clearing and temporary mounting medium. For permanent slides, the edges of coverslips were sealed with nail polish.

Lactophenol was prepared by mixing the following

Phenol	-	1 part
Distilled water	-	1 part
Lactic acid	-	1 part
Glycerine	-	2 parts

5. Measurements

The dimensions of the nematodes were taken by using an ocular micrometer. Stage micrometer was used to find out one ocular division which is calculated as follows

$$1 \text{ ocular division} = \frac{\text{No. of divisions on stage micrometer}}{\text{No. of divisions of ocular micrometer}} \times 0.01\text{mm}$$

de Man's (1884) formula was used to denote the dimension of the nematodes. The illustrations were drawn with the help of a drawing tube attached to Nikon Optiphot 2 and Nikon Alphaphot 2 (YS2) microscopes.

6. Abbreviations used

n = number of specimen

L = Total body length

a = Body length % greatest body width

b = Body length % distance from anterior end to the oesophagus

c = Body length % tail length

V = Distance of vulva from anterior end x 100 %body length

7. Type material

Type material has been labelled and deposited in the nematode collection of the Department of Zoology, Aligarh Muslim University, Aligarh-202002 (UP), India.

RESULTS

Chapter – I

Superfamily Thelastomatoidea

The superfamily Thelastomatoidea is one of the two superfamilies in the order Oxyurida, the pinworms. The members of the superfamily Thelastomatoidea occur in invertebrates, essentially arthropod hosts and their taxonomy has been treated separately from that of the Oxyuroidea, pinworm parasites of vertebrates. Poinar (1977a) gave a key to pinworm genera parasitic in invertebrate hosts but his work was in large part a translation of Kloss (1960) and Skrjabin *et al.*, (1966), who had confused Oxyurida with Rhigonematida. The superfamily "Thelastomatoidea" has been diversely subdivided, but the extensive subdivision by Kloss (1960), Skrjabin *et al.*,(1966) and Poinar (1983) cannot be justified as they are mainly based on plesiomorphic characters. Adamson & Waerebeke (1992 a,b,c) divided the superfamily Thelastomatoidea into five families viz., Thelastomatidae, Protrelloididae, Hystrignathidae, Travassosinematidae and Pseudonymidae which is accepted and followed by subsequent workers. In their revision the first three families viz., Thelastomatidae, Protrelloididae, Hystrignathidae are defined in the same manner as had been suggested by Chitwood (1932) and the family Travassosinematidae is considered equivalent to Chitwoodiellidae of Spiridonov (1984a) while the family Pseudonymidae is roughly equivalent to Gyoeryiinae of Poinar (1977a).

Key to families of Thelastomatoidea

1. Vulva posterior to base of oesophagus.....2

- Vulva anterior to base of oesophagus.....Protrelloididae Chitwood, 1932

2(1). Cervical cuticle with transverse rows of spines.....

.....Hystrignathidae Travassos, 1920

- Cervical cuticle without spines.....3

3(2). Eggs with filaments.....4

- Eggs without filaments.....Thelastomatidae Travassos, 1929

4(3). Egg filaments twisted around shell, polar egg filaments absent.....Pseudonymidae (Kloss, 1958) Adamson, 1989

- Egg filaments not twisted around shell, polar egg filaments present.....Travassosinematidae Rao, 1958

Family **Thelastomatidae** Travassos, 1929

This is by far the largest family of the superfamily Thelastomatoidea. Travassos (1920) proposed two families Lepidonemidae and Isakidae to accommodate all the Oxyurid parasites of arthropods. He further divided the family Lepidonemidae into 2 subfamilies Lepidoneminae and Hystrignathinae.

Bayliss & Daubney (1926) suppressed both families proposed by Travassos and distributed the genera previously placed in these families among Oxyuridae and Rhabditidae.

Later, Travassos (1929) revised his previously suggested classification, restricting the family Lepidonemidae to three genera *Lepidonema* Cobb, *Hystrignathus* Leidy and *Pulchrocephala* Travassos and suppressing the sub-family Hystrignathidae Travassos. He proposed a new family Thelastomatidae and divided it into four sub-families viz., Thelastomatinae, Aorurinae, Oniscolinae and Ransomnematinae.

Chitwood (1932) merged the family Lepidonemidae with Thelastomatidae and recognised only 3 sub-families of the family Thelastomatidae viz., Thelastominae, Hystrignathinae and Protrelloidinae. He proposed the subfamily Protrelloidinae to accommodate all those thelastomatids having their vulva anterior to the base of the oesophagus. The subfamily Aorurinae Walton, 1927 was synonymised with Thelastominae by Chitwood (1932). The remaining two subfamilies of Travassos i.e., Oniscicolinae and Ransomnematinae were removed

from the Thelastomatidae; Oniscicolinae was placed in the family Heterakidae. Chitwood also removed the genus *Cruznema* from the Ransomnematinae and referred it provisionally to the Atractidae, suggesting that the sub-family Ransomnematinae might belong with Oniscicolinae to the Heterakidae. Later, Chitwood and Chitwood (1937) placed it in the family Atractidae.

Basir (1956) considered Thelastomatidae as a distinct natural group under Oxyuroidea and did not agree with the division of Thelastomatidae in Sub-families given by Chitwood.

In the present study, the family Thelastomatidae is considered a valid family under the superfamily Thelastomatoidea without its subdivision into subfamilies.

Key to genera of Thelastomatidae

1. Egg bearing spine-like outgrowths.....*Gryllophila* Basir, 1942

- Egg without spine-like outgrowths.....2

2(1). Buccal cavity provided with cuticular modifications.....3

- Buccal cavity without cuticular modifications.....4

3(2). Buccal cavity with 3 tooth-like projections, eggs elongate and has longitudinal lines.....*Severianoia* (Schwenk, 1926) Travassos, 1929

- Buccal cavity with intermediate thickenings of the cuticle which form small teeth, eggs oval without longitudinal lines.....

.....*Fontonema* Chitwood, 1930

4(2). Isthmus surrounded by nerve ring.....5

- Isthmus not surrounded by nerve ring.....9

5(4). Egg with operculum.....*Suifunema* Chitwood, 1932

- Egg without operculum.....6

6(5). Corpus clavate.....7

- Corpus pyriform.....*Aoruroides* Travassos & Kloss, 1958

7(6). Egg elongate, flattened on one side.....8

- Egg oval to ellipsoidal.....*Johnstonia* Basir, 1966

8(7). 4 pairs of caudal papillae in male.....*Galinanema* Spiridonov, 1984

- 5 pairs of caudal papillae in male.....*Golovatchnema* Spiridonov, 1984

9(4). End bulb with valve.....10

- End bulb without valve.....*Robertia* Travassos & Kloss, 1960

10(9). Spicule present.....11

- Spicule absent.....21

11(10). Caudal papillae 3 pairs.....12

- Caudal papillae 4-5pairs.....14

12(11). Female tail filiform.....*Euryconema* Chitwood, 1932

- Female tail not filiform.....13

13(12). Cephalic extremity with expanded 2nd annule.....

.....*Leidynemella* Chitwood & Chitwood, 1934

- Cephalic extremity with simple 2nd annule.....*Cameronia* Basir, 1948

14(11). Female tail not filiform; 4 pairs of caudal papillae in male.....15

- Female tail filiform;4-5 pairs of caudal papillae in male.....16

15(14). Ovary monodelphic.....*Galebia* Chitwood, 1932

- Ovary didelphic.....*Wetanema* Dale, 1967

16(14). Female tail filiform ; caudal papillae 4 pairs in male.....17

- Female tail filiform ; caudal papillae 5pairs in male.....

.....*Leidynema* Schwenk in Travassos, 1929

17(16). Ovary didelphic, uteri amphidelphic.....18

- Ovary didelphic, uterus prodelphic...*Hammerschmidtiella* Chitwood, 1932

18(17). Vulva near midbody.....19

- Vulva at posterior third of body.....20

19(18). Egg oval to ellipsoidal.....*Thelastoma* Leidy,1849

- Egg elongate.....*Tetleyus* Dale, 1964

20(18). Excretory pore posterior to base of oesophagus.....

.....*Cephalobellus* Cobb,1920

- Excretory pore anterior to base of oesophagus.....*Desmicola* Basir,1956

21(10). Oral opening surrounded by membranous flaps.....*Coronostoma* Rao,1958

- Oral opening not surrounded by membranous flaps.....22

22(21). Egg ellipsoidal to elongate.....23

- Egg broadly oval.....25

23(22). Egg ellipsoidal.....24

- Egg elongate.....*Cranifera* Kloss,1960

24(23). 3 pairs of caudal papillae in male.....*Blattophila* Cobb,1920

- 4 pairs of caudal papillae in male.....*Aorurus* Leidy,1849

25(22). 2 pairs of caudal papillae in male.....*Buzionema* Kloss,1966

- 4 pairs of caudal papillae in male.....26

26(25). Gonadsdidelphic.....27

- Gonads monodelphic.....*Blatticola* Schwenk, 1926

27(26). Vulva at posterior-third of body, anterior vulval lip not swollen .....*Cordonicola* Ali & Farooqui, 1969

- Vulva at midbody, anterior vulval lip swollen.....

.....*Corydiella* Rao & Rao, 1965

Genus *Thelastoma* Leidy, 1849

The genus *Thelastoma* was erected by Leidy (1849) to accommodate *T. attenuatum* as its type species.

Leidy (1848) proposed a genus *Aorurus* having two subgenera namely *Aorurus (Streptostoma) agile* and *A. (Thelastoma) attenuatum*. Later, he (1850) added 3 species, namely *A.(T.) appendiculatum*, *A.(T.) labiatum* and *A.(T.) robustum* to the subgenus *Thelastoma*. In 1851 Leidy synonymised two species of Hammerschmidt, namely *O. gracilis* Hammerschmidt, 1838 and *O. dilatata* Hammerschmidt, 1847 as *T. gracile* and *T. dilatatum* respectively and added to the subgenus *Thelastoma*. In the same year Leidy elevated both the subgenera to the rank of genus, namely *Strepstomum* and *Thelastomum*.

Schwenk (1926) proposed two new genera *Blatticola* and *Bulhoesia*, the former to accommodate *Oxyuris blatticola* Galeb and the latter for three new species viz., *B. magalhaes*, *B. icemi* and *B. severianoi*.

Walton (1927) re-examined the collections of Leidy and proposed to revive the genus *Aorurus* Leidy with its original subgenera *Thelastoma* and *Streptostoma*. He gave a revised diagnosis as well as a list of the species to be included in each subgenus.

Magalhaes (1900) described an Oxyurid from a cockroach and called it *Oxyuris bulhoesi*. Travassos (1929) in his synopsis of nematodes of arthropods provided a list of all the species which he felt could be referred to the genus

Thelastoma. He synonymised the genus *Bulhoesia* Schwenk, 1926 with *Thelastoma* and placed two of its species, *B. magalhaes* and *B. icemi* under *Thelastoma* while for the third *B. severianoia* he proposed a new genus namely *Severianoia*. Cobb (1929a) divided the genus *Thelastoma* into two subgenera and described two new species from a millipede calling them *T.(Thelastoma) spicatum* and *T.(Thelastomellum) myolabiatum*. However, it was not recognised by subsequent authors. Basir (1956) gave detailed account of 8 species of the genus *Thelastoma* and erected a new genus *Schwenkiella* for the species of *Thelastoma* possessing excretory pore posterior to the base of oesophagus. Tewarson & Gupta (1976) did not agree with the distinction of the two genera *Schwenkiella* and *Thelastoma* since they found that only distinguishing character, the position of excretory pore was of variable nature and therefore synonymised the genus *Schwenkiella* with the genus *Thelastoma*. Parveen & Jairajpuri (1980,1983) considered the position of the excretory pore valid enough for the two genera *Thelastoma* and *Schwenkiella* and described two new species *S. basiri* and *S. atheri* under the genus *Schwenkiella*.

Adamson & Waerebeke (1992a) did not accept the separation between *Thelastoma* and *Schwenkiella* and hence transferred all the species of *Schwenkiella* to the genus *Thelastoma* Rizvi and Jairajpuri (1995) transferred *S. atheri* Parveen & Jairajpuri,1983 and *S. delhiensis* Mojumdar & Khan,1992 to the genus *Thelastoma*. Further, they (1997) proposed a new name *T. rafiai* for

T. basiri Parveen & Jairajpuri, 1980 not Farooqui,1970. Upton *et al.*, (1983) described a new species *T. collare* and summarised the known species and synonyms of *Thelastoma*. They listed 39 valid species under the genus *Thelastoma* out of which 6 species are described from India. Adamson and Waerebeke (1992a) while revising the superfamily Thelastomatoidea listed 51 valid species under the genus *Thelastoma* of the family Thelastomatidae from the world over. Barus and Koubkova (2002) described a new species of the genus *Thelastoma* from Croatia.

So far the genus contains 54 species described from all over the world out of which 19 species are reported from India.

Generic diagnosis (emended)

Female: Cephalic extremity formed by circumoral annule and enlarged second annule. Mouth surrounded by 8 labial papillae. Amphids present. Lateral alae present or absent. Buccal cavity simple. Oesophagus consisting of an anterior cylindrical corpus, an isthmus and a posterior valvular bulb. Excretory pore pre- or post-oesophageal bulb or at the level of the base of the bulb. Tail long filiform about $1/3^{rd}$ to $1/4^{th}$ of the total body length. Vagina short, muscular and anteriorly directed directed with well developed vulval lip. Vulva at or posterior to mid-body. Eggs broadly oval.

Male: Cephalic extremity formed by single expanded annule. Lateral alae present or absent. Tail elongate filiform. Caudal papillae 4 pairs, one pair pre anal, one pair adanal and one median duplex post anal papillae on genital cone. One pair of

papillae on caudal appendage some distance away from the anus. Testes single. Spicule present or absent.

Thelastoma periplaneticola Leibersperger, 1960

(Fig.1)

Thelastoma periplaneticola was first described by Leibersperger from Germany with no record of the species from any place in the world. The present author found the species from India (Manipur) and thereby represents the first record from Oriental region.

Dimensions

Females (n = 20)

a = 11.05 - 17.17 (13.206 ± 1.478); b = 5.05 - 7.20 (5.924 ± 0.686) ; c = 2.82 - 3.537 (3.166 ± 0.198); L = 2.138 - 3.474 (2.655 ± 0.364) mm; W = 0.142 - 0.284 (0.204 ± 0.0416) mm; oesophagus = 0.402 - 0.506 (0.447 ± 0.029) mm; excretory pore = 0.343 - 0.510 (0.417 ± 0.034) mm; nerve ring = 0.170 -0.218 (0.194 ± 0.012) mm; buccal cavity = 12.15 - 14.58 x 12.15 - 14.48 (12.636 ± 0.997 x 13.30 ± 0.619) μm; eggs = 70.47 - 85.05 x 46.17 - 60.75 (77.94 ± 4.322 x 55.89 ± 3.612) μm; T = 0.657 -1.021 (0.838 ± 0.118) mm; vulva = 1.09 - 1.717 (1.241 ± 0.168) mm.

Males (n = 2)

a = 8.70 - 10.62 (9.66 ± 1.357); b = 5.25 - 6.09 (5.659 ± 0.579); c = 3.02 -3.346 (3.24 ± 0.311); L = 0.966 - 1.487 (1.226 ± 0.368) mm; W = 0.111 - 0.140 (0.125 ± 0.020) mm; oesophagus = 0.184 - 0.245 (0.214 ± 0.043) mm; buccal cavity =

14.58 - 17.01 x 9.72 (15.795 ± 1.718 x 9.72) μm; tail = 0.319 - 0.429 (0.374 ± 0.077) mm.

Description

Body small, cylindrical and tapering towards anterior end and into a filiform tail posteriorly. Cuticle annulated, lateral alae present only in males. Mouth surrounded by 8 labiopapillae, amphids distinct. Buccal cavity distinct. Oesophagus long with a cylindrical corpus, a short isthmus and an end bulb. Excretory pore a little above the base of the oesophagus in females but not seen in males. Vulva a little anterior to midbody, vulval lip well developed. Ovaries amphidelphic, vagina directed anteriorly. Tail of both sexes filiform forming 1/3th of the total body length. Eggs oval in shape. Testes single and reflexed at the tip. Caudal papillae 4 pairs consisting of 1 pair pre anal, one median duplex papillae on the genital cone and one pair on caudal appendage a little away from the anus. Spicule absent.

Host: *Periplaneta americana*

Habitat: Intestine

Locality: Imphal, Manipur (North East India)

Remarks: All measurement are in conformity with the range given by Leibersperger, 1960 except in having somewhat smaller eggs (72 - 102 x 58 - 97 μm) and slightly shorter female tail (tail = 0.55 - 0.94 mm).

Genus *Leidynema* Schwenk (in Travassos, 1929)

Synonym: *Spinicephala* Kloss, 1960

The genus *Leidynema* was proposed by Schwenk (in Travassos,1929) to accommodate *Oxyuris blattae orientalis*. Leidy (1850) cited *Oxyuris blattae orientalis* Ham.,1847 as being the same species as his *Thelastomum appendiculatum*. However, *Oxyuris blattae orientalis* now being regarded as the synonym of *Hammerschmidtiella diesingi*, the type species of the genus *Leidynema* will have the name of *L. appendiculatum* which is meant for the type species of the genus by Schwenk (in Travassos, 1929) and the same was described by Chitwood (1932). Chitwood (1932) also added two species *L. cranifera* and *L. delatorei*. Chitwood and Chitwood (1934) added a fourth species *L. nocalum* to the genus. Basir (1956) transferred *Oxyuris socialis* (Leidy, 1850) to *Leidynemella* (Chitwood and Chitwood, 1934) which is now transferred to the genus *Leidynema* by Adamson and Waerebeke (1992a). Farooqui (1967) described *L. periplaneti* from *Periplaneta americana* and *L. schwenki* from *Blatta orientalis*. Waerebeke (1978) described *L. portenstosae* from Madagascar. The type species *L. appendiculatum* is cosmopolitan in distribution and reported from *P. americana, P. australasiae, Blaberus atropos Blatta orientalis* and *Hormetica scrobiculata*. Dobrovolny and Ackert (1934), Todd(1941,1944) and Adamson & Clease (1989) studied aspects of embryonic and post-embryonic development and Hominick & Davey (1972a,1972b,1973) studied its interaction with other

pinworms in *P. americana*. At present the genus includes 7 species. In the present study type species *L. appendiculatum* has been collected from *P. americana*. The present species is reported for the first time from Manipur, North East India.

Diagnosis (emended)

Female : Cephalic extremity formed by two annules in females. Lateral alae present. Eggs large, elongate and crescent-shaped. Female tail long, filiform or attenuated. Oesophageal corpus divided into narrow anterior and broad posterior portions of roughly equal length, isthmus short, endbulb spherical. Intestine with blind diverticulum. Vulva near midbody.

Male: Cephalic extremity formed by single expanded annule. Lateral alae present or absent. Spicule present or absent. Caudal extremity in males abruptly truncate with or without short terminal spine (thorn like process on its ventral side) or provided with several protuberances. Caudal papillae 3-5 pairs.

Leidynema appendiculatum (Leidy, 1850) Chitwood, 1932

(Fig. 2)

Synonyms

Thelastoma appendiculatum Leidy, 1850
Anguillula appediculata (Leidy) Diesing, 1861
Aorurus appendiculatus(Leidy) Walton,1927
Leidynema appendiculata americana Serano Sanchez, 1947
Oxyuris blattae Hammerschmidt of Galeb(1878a)
Oxyuris blattae orientalis Hammerschmidt 1847 of Leidy (1851) & Butschli(1871)

Dimensions

Females (n = 9)

a = 10.03 - 12.6 (11.146 ± 0.888); b = 5.77 - 7.99 (6.694 ± 0.869); c = 4.05 - 4.71 (4.301 ± 0.235);V = 42.42 - 48.16 (44.895 ± 1.900); L = 2.168 - 3.213 (2.670 ± 0.387) mm; W = 0.206 - 0.284 (0.239 ± 0.026) mm; buccal cavity = 9.72 - 12.15 x 12.15 - 13.36 (10.26 ± 1.071 x 12.418 ± 0.533) µm; eggs = 92.34 - 104.49 x 34.02 - 36.45 (96.66 ± 4.343 x 35.37 ± 1.280) µm; tail = 0.491 - 0.756 (0.621 ± 0.0943) mm ; 2nd annule = 4.86 - 7.29 x 34.02 - 43.74 (5.771 ± 1.257 x 39.487 ± 3.615) µm; 3rd annule = 6.07 - 9.72 x 38.88 - 53.46 (7.133 ± 1.515 x 46.17 ± 4.683) µm; 4th annule = 7.29 - 10.93 x 43.74 - 55.89 (8.655 ± 1.367 x 51.63 ± 5.164) µm; 5th annule = 8.5 - 12.15 x 48.6 - 68.04 (10.173 ± 1.113 x 57.56 ± 5.843) µm; 6th annule = 9.72 - 12.15x 53.46 - 70.47 (10.933 ± 1.086 x 63.585 ± 6.034) µm.

Males (n = 8)

a = 9.15 - 12.57 (10.68 ± 1.394); b = 3.61 - 5.69 (4.745 ± 0.947); c = 64.33 - 124.33 (83.538 ± 21.384); tail = 0.009 - 0.012 (0.010 ± 0.001) mm; L = 0.579 - 1.119 (0.843 ± 0.230) mm; W = 0.058 - 0.097 (0.077 ± 0.012) mm.

Description

Female : Body cylindrical, tapering at both ends, straight upon fixation. Cuticle closely annulated throughout the length of the body. Lateral alae prominent, each ala terminating in a spine-like projection. Mouth surrounded by eight large submedian labiopapillae and pair of amphids. Oesophagus 0.368 - 0.446 mm long consisting of a corpus 0.262 - 0.327 mm long. The corpus is divided into anterior cylindrical part 0.126 - 0.150 mm long, 0.026 - 0.031 mm wide; and posterior broader part 0.060 - 0.153 mm long, 0.039 - 0.055 mm wide. Isthmus distinct, 0.014 - 0.019 mm long, 0.026 - 0.034 mm wide. End bulb 0.078 - 0.102 mm long, 0.083 - 0.099 mm wide. Intestine enlarged at the anterior part and provided with a posteriorly directed intestinal diverticulum. Nerve ring at 0.137 - 0.157 mm from anterior end. Excretory pore at 0.510 - 0.628 mm from anterior end. Gonads amphidelphic. Vulva transverse, slightly posterior to middle of the body, 1.020-1.427 mm from anterior end. Vagina sclerotized, muscular and directed anteriorly. Eggs elliptical, laid singly. Tail filiform. Anus situated at 0.1677 - 2.457 mm from anterior end. Head and first annule together measures 12.15 - 14.58 μm in length

and 34.02 - 38.88 μm in width. There is gradual increase in the length and width of the annules upto 6th annule from anterior end.

Male: Small body, curved at the posterior end upon fixation. Cuticle annulated throughout the length. Lateral alae present. Head annule 9.42 - 9.72 μm long, 17.01 - 21.87 μm wide. Buccal cavity 5.65 - 9.72 μm long, 7.29 - 12.15 μm wide. Oesophagus 0.157 - 0.206 mm long having a corpus of uniform diameter, 0.102-0.123 mm long, 0.013 - 0.019 mm wide; a short isthmus 0.021 - 0.024 mm long, 0.009 - 0.012 mm wide. End bulb 0.034 - 0.041mm long, 0.029 - 0.038 mm wide. Nerve ring situated at 0.108 - 0.127 mm from anterior end and excretory pore at 0.418 mm from anterior end. Testes single, reflexed at the tip. Spicule 31.59 - 32.8 μm long. Anus situated at 0.586 - 1.110 mm from anterior end. Caudal papillae 3 pairs in which 1 pair is subventral preanal, 1 pair ventral post anal and 1 pair small subdorsal post anal papillae. Caudal extremity in male abruptly truncate with a short terminal spine on its ventral side.

Host : *Periplaneta americana*

Habitat : Posterior gut

Locality : Imphal, Manipur (North East India)

Remarks: The present specimens conform well with the description and measurements given by earlier workers.

Key to species of *Leidynema*

1. Males with several protuberances in posterior region..... ..... *portentosae* Waerebeke, 1978

- Males without protuberances in the posterior region.....2

2(1). Spicule = 63µm long in male..... ..... *socialis*(Leidy,1850)Adamson & Waerebeke,1992a

- Spicule less than 63µm long in male.....3

3(2). Lateral alae present in females only.....4

- Lateral alae present in both sexes.....5

4(3). Lateral alae in female ends in backwardly pointed projection..... ..... *schwenki* Farooqui,1967

- Lateral alae in female do not end in backwardly pointed projection.....6

5(3). Female oesophagus 1/6 – 1/5th of body length; males with 5 pairs of caudal papillae..... *periplaneti* Farooqui,1967

- Female oesophagus 1/8th of body length; males with 3-5 pairs of caudal papillae..... *appendiculatum* (Leidy,1850)Chitwood,1932

6(4). Lateral alae in female extending along whole length of body without spinous process; cuticular bosses present..... *delatorei*Chitwood,1932

- Lateral alae in female start from mid-body and continuous upto tip of tail with spinous process; cuticular bosses absent.....

.....*stylopygi* Biswas&Chakravarty,1963

TABLE-2

Comparative measurement chart of the species of genus *Leidynema*

	L. delatorei	*L.periplaneti*	*L.portentosae*	*L.schwenki*	*L.socialis*	*L.stylopygi*	*L.appendiculatum*
Characters	(mm)*	(mm)*	(mm)*	(mm)*	(mm)*	(mm)*	(mm)
Female							
Length	3.4-3.78	1.99-2.6	1.85-2.44	1.5-2.8	2.117-4.656	3.10-3.22	2.168-3.213
Width	0.335-0.450	0.23-0.38	0.130-0.208	0.39-0.41	0.095	0.29-0.31	0.206-0.284
Oesophagus	0.506-0.570	0.37-0.43	0.460-0.598	0.31-0.38	-	0.40-0.42	0.368-0.446
Excretory pore	0.840-0.920	0.59-0.62	0.650	0.46-0.64	-	-	0.510-0.628
Nerve ring	-	0.13-0.19	0.208	0.11-0.14	-	0.14-0.15	0.137-0.156
Egg	100-108 x 40-46µm	11 x 50µm	95-107 x 35-38µm	122 x 51µm	69 x 38µm	-	92.34-104.49 x 34.02-36.45µm
Tail	-	0.45-0.54	0.510-0.840	0.34-0.42	1/5 of BL	0.54-0.55	0.491-0.756
Vulva	1.4-1.63	0.53-1.4	1.10-1.22	1.2-1.38	-	1.20-1.24	1.020-1.427
Male							
Length	0.9	0.76	0.81-1.06	0.81	1.27-1.693	-	0.579-1.119
Width	0.060	0.09	0.060-0.082	0.09	0.0635	-	0.058-0.097
Oesophagus	0.189	0.12	0.270-0.328	0.15	-	-	0.157-0.206
Excretory pore	-	0.16	0.432	-	-	-	0.418
Nerve ring	-	0.05	0.182	0.09	-	-	0.108-0.127
Buccal cavity	-	10-20µm	-	11 x 2µm	-	-	5.65-9.72 x 7.29-12.15µm
Tail	-	0.02	-	0.2	1/8 of BL	-	0.009-0.012
Spicule	37µm	30µm	42 x 3µm	30µm	63.5µm	-	31.59-32.8µm
Caudal papillae	3 pairs	5 pairs	3 pairs	5 pairs	5 pairs	-	3 pairs
Corpus	0.145 x 0.010	0.06	0.185-0.229 x 0.019-0.022	0.102 x 0.016	-	-	0.102-0.123 x 0.013-0.019
Isthmus	0.014 x 0.010	0.03	0.065-0.071 x 0.013-0.015	0.012-0.013	-	-	0.021-0.024 x 0.009-0.012
Bulb	0.030 x 0.028	0.03	0.011-0.016 x 0.36-0.44	0.041-0.039	-	-	0.034-0.041 x 0.029-0.038

* All measurements from original descriptions

Genus *Gryllophila* Basir, 1942a

Synonym: *Neyraiella* Serrano Sanchez, 1947

Basir (1942a) proposed the genus *Gryllophila* to accommodate the worms collected from *Gryllotalpa africana*. The type species, *Gryllophila skrjabini* (Sergiev, 1923) Basir, 1956 has been reported from USSR, Spain and India. Serrano Sanchez (1947) described the same worms from another species of *Gryllotalpa* and proposed a new genus *Neyraiella*. Basir (1956) synonymised the genus *Neyraiella* with *Gryllophila*. Farooqui (1970) described *Gryllophila gryllotalpae* from Maharastra, India. Parveen & Jairajpuri (1981) described a new species *G. basiri* from North India. Rizvi *et al.*(2002) described *G. nihali* from north India. The total number of species described under the genus till date is four.

Generic diagnosis

Female: Cephalic extremity formed by circumoral annule and posterior expanded annule. Mouth opening surrounded by eight labiopapillae and a pair of amphids . Oesophageal corpus cylindrical, isthmus cylindrical. Vulva in posterior quarter of the body. Vagina long and anteriorly directed. Uterus extending anteriorly and flexing posteriorly before dividing into two branches. Gonad amphidelphic. Eggs very large, with or without spine-like outgrowths, elongate, deposited in string held together by uterine secretions. Tail conical to attenuate.

Male: Cephalic extremity formed by single expanded annule. Caudal extremity with prominent genital cone. Caudal papillae 3-6 pairs, single median papilla

present or absent. Spicule single. Caudal appendage, narrowing abruptly posterior to last pair of caudal papillae, rest of the papillae borne on genital cone.

Gryllophila skrjabini (Sergiev, 1923) Basir, 1956

(Fig. 3)

Dimensions

Females (n = 11)

a = 6.903 - 9.875 (8.250 ± 0.927); b = 5.089 - 7.016 (5.766 ± 0.640); c = 7.734 - 10.859 (8.991 ± 1.206); V = 72.186 - 76.793 (75.55 ± 1.417); L = 2.051 - 3.375 (2.467 ± 0.437) mm ; W = 0.235 - 0.392 (0.300 ± 0.049) mm; eggs = 121.5 - 140.94 x 75.33 - 92.34 (136.96 ± 7.230 x 83.282 ± 5.333) µm ; tail = 0.196 - 0.363 (0.278 ± 0.054) mm.

Males (n = 9)

a = 7.022 - 10.175 (8.302 - 1.197); b = 4.184 - 6.798 (5.783 ± 0.724); c = 9.024 - 14.602 (12.068 ± 1.842); L = 0.749 - 1.285 (1.0863 ± 0.159) mm; W = 0.098 - 0.176 (0.133 ± 0.0293) mm; tail = 0.083 - 0.098 (0.090 ± 0.006) mm.

Description

Female: Cephalic extremity formed by circumoral annule and posterior expanded annule. Head and first annule together 17.01 - 24.3 µm long, 38.88 - 43.74 µm wide. Oral opening has 8 labial papillae, amphids present. Cuticle annulated. Oesophagus 0.402 - 0.481 mm long. Corpus cylindrical, 0.270 - 0.333 mm long, 0.029 - 0.039 mm wide. Isthmus cylindrical, 0.039 - 0.044 mm long, 0.029 - 0.039 mm wide. End bulb spherical, 0.088 - 0.103 mm long, 0.088 - 0.103 mm wide. Nerve ring at 0.196 - 0.0.235 mm from anterior end. Excretory pore quite posterior

to base of oesophagus, 0.736 - 1.148 mm from anterior end. Anus 1.855 -3.051 mm from anterior end. Vulva in posterior quarter of the body, 1.590 - 2.580 mm from anterior end. Buccal cavity 12.15 - 14.58 μm long, 7.29 - 9.72 μm wide. Ovaries two, both connected with their respective uteri at about the level of the excretory pore, the uteri running parallel in posterior direction, uniting a little behind the level of the vulva and giving rise to a single uterus which runs anteriorly coming upto the level of the excretory pore where it is reflexed and runs backwards till it meets the vagina. Vagina long and anteriorly directed. Eggs very large elongate with spine-like outgrowths, deposited in strings held together by uterine secretions. Tail conical.

Male: Cephalic extremity formed by single expanded annule. Body small, curved ventrally upon fixation. Cuticle annulated throughout its length. Lateral alae absent. Buccal cavity short and cylindrical, 14.48 - 17.01 μm long, 4.86 - 7.29 μm wide. Oesophagus 0.177 - 0.194 mm long. Corpus 0.102 - 0.114 mm long, 0.017-0.026 mm wide. Isthmus 0.029 - 0.034 mm long, 0.009 - 0.014 mm wide. End bulb 0.043 - 0.051 mm long, 0.038 - 0.048 mm wide. Nerve ring at 0.075 - 0.104 mm from anterior end. Excretory pore situated behind the base of oesophagus, 0.432 - 0.510 mm from anterior end. Single spicule, 51.03 - 60.75 μm long. Tail short, ending in a pointed appendage. Caudal papillae 3 pairs, the first two pairs situated on the genital cone, the first pair slightly pre-anal and the second pair

slightly post-anal, and the third pair lying near the tip of the tail i.e. at the origin of the caudal appendage.

Host : *Gryllotalpa africana*

Habitat : Intestine

Locality : Imphal, Manipur (North East India)

Remarks: The present specimen conform well with the measurements and illustration reported by earlier workers except in having smaller eggs (Eggs = 170 – 190 μm x 100-110μm).

Key to species of *Gryllophila*

1. Egg shell with spine-like outgrowths.... *skrjabini* (Sergiev,1923)Basir,1956

\- Egg shell without spine-like outgrowths.....2

2(1). Caudal papillae 3 pairs with a single median papilla..... *nihali* Rizvi *et al.*,2002

\- Caudal papillae 5-6 pairs without a single median papilla.....3

3(2). Caudal papillae 5 pairs..... *gryllotalpae* Farooqui,1970

\- Caudal papillae 6 pairs..... *basiri* Parveen & Jairajpuri,1981

TABLE-3

Comparative measurement chart of the species of genus *Gryllophila*

Characters	*G. gryllotalpae* (mm)*	*G. basiri* (mm)*	*G. nihali* (mm)*	*G. skrjabini* (mm)
Female				
Length	2.6-3.15	1.45-1.68	2.2-2.44	2.051-3.375
Width	0.31-0.61	0.164-0.165	0.27-0.33	0.235-0.392
Oesophagus	0.41-0.46	0.37-0.386	0.418-0.430	0.402-0.481
Excretory pore	0.79-0.95	0.66-0.70	0.83-0.85	0.736-1.148
Nerve ring	0.2-0.22	0.197-0.200	0.22-0.24	0.196-0.235
Tail	0.27-0.28	0.179-0.180	0.22-0.24	0.196-0.363
Vulva	0.59-0.79	1.07-1.29	1.7-1.95	1.590-2.580
Egg	100-140 x 65-84mm	50-64 x 28-43mm	135-138 x 66-68mm	121.5-140.94 x 75.33-92.34mm
Male				
Length	1.12-1.14	0.9	0.75-0.975	0.749-1.285
Width	0.13-0.15	0.1	0.09-0.10	0.098-0.176
Oesophagus	0.17-0.20	0.171	0.167-0.183	0.177-0.194
Excretory pore	-	0.307	-	0.432-0.510
Nerve ring	0.12-0.13	0.107	0.080-0.090	0.075-0.104
Tail	0.1-0.11	0.11	0.05-0.09	0.083-0.098
Spicule	44-57mm	50mm	54-57mm	51.03-60.75mm
Caudal papillae	5 pairs	6pairs	3 pairs + 1 median Single papilla	3 pairs

*All measurements from original descriptions

Genus *Hammerschmidtiella* Chitwood, 1932

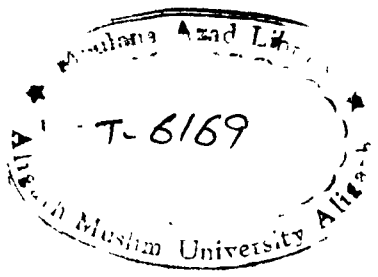
Synonym: *Welchiella* Gupta & Kaur, 1978

The genus *Hammerschmidtiella* was proposed by Chitwood (1932) to accommodate *Oxyuris diesingi* Hammerschmidt, 1838. Chitwood (1932) synonymised *Oxyuris diesingi* to *H. diesingi* which later on become the type species of the genus and is followed by subsequent workers. Serrano Sanchez (1947) described *H. neyrae* from Spain. Rao (1958) and Rao & Rao (1965c) reported *H. manohari* and *H. singhi* from South India.. Biswas and Chakravarty (1963) described *H. aspiculus* from *Periplaneta americana* from India. Kloss (1966) described *H. acreana* from Brazil. Gupta and Kaur (1978) described a new species *Welchiella poinari*, the genus was later synonymised with *Hammerschmidtiella* as *H. poinari* by Adamson and Waerebeke (1992a). Spiridonov (1948b) described *H. cristata* from diplopods of Cuba. Adamson and Nasher (1987) reported *H. andersoni* from Saudi Arabia. Zervos (1987a) described a new species *Suifunema mackenziei* which was later transferred to the genus *Hammerschmidtiella* as *H. mackenziei* by Adamson and Waerebeke(1992a).Singh & Kaur(1988) reported a new species, *H. basiri* from India. So far 11 species has been described world over. Several worms belonging to the type species, *H. diesingi* were collected during the present study.

Generic diagnosis (emended)

Female: Body spindle shaped. Cephalic extremity formed by two annules and cervical region with variable number and arrangement of enlarged annules. Oesophageal corpus with a pseudobulb, cylindrical isthmus. Vulva in anterior-third of the body, vagina and uterus posteriorly directed. Didelphic, prodelphic. Eggs elongate, tail attenuate to filiform.

Male: Cephalic extremity formed by single expanded annule. Oesophageal corpus clavate. Caudal extremity abruptly truncate, posterior to anus with spine-like appendage. Caudal papillae absent or if present consisting of one pair subventral preanal, one pair lateral adanal, one pair subventrals just posterior to anus and one duplex papilla at the base of the caudal appendage. Spicule present or absent.



Hammerschmidtiella diesingi (Hammerschmidt, 1838) Chitwood, 1932

(Fig. 4)

Synonyms: *Oxyuris diesingi* Hammerschmidt, 1838
Oxyuris blattae orientalis Hammerschmidt, 1847
Streptostoma gracile Leidy, 1850
Anguilulla macrura Diesing, 1851
Leidynemamella periplaneticolae Singh & Singh, 1955
H. bareillyi Sharma & Gupta,1983
Blattophila americana Singh, 1987
B. basiri Singh,1987

Dimensions

Females (n = 13)

a = 10.31 - 13.89 (12.026 ± 1.306); b = 6.95-10.35 (8.472 ± 0.928); c = 2.61-3.62 (3.090 ± 0.266); V = 19.12 - 25.15 (22.28 ± 1.648); L = 2.228-3.316 (2.690 ± 0.348) mm ; W = 0.166-0.284 (0.226 ± 0.038) mm; oesophagus = 0.285-0.344 (0.317 ± 0.018) mm ; buccal cavity = 4.86 x 9.72 μm; eggs = 72.9 - 80.19 x 29.16 - 34.02 (77.5 ± 2.885 x 31.02 ± 2.021) μm; tail = 0.756 - 0.991 (0.868 ± 0.079) mm ; vulva = 0.441- 0.834 (0.603 ± 0.118) mm.

Males (n = 7)

a = 10.40 - 14.79 (12.207 ± 1.696); b = 4.089 - 5.88 (5.095 ± 0.701); c = 4.33 - 8.04 (6.024 ± 1.275); L = 0.487 - 0.853 (0.683 ± 0.144) mm; W = 0.034 - 0.082 (0.058 ± 0.018) mm; tail = 0.104 - 0.148 (0.114 ± 0.015) mm; spicule = 26.73 - 36.45 (31.93 ± 3.268) μm.

Description

Female: Body spindle-shaped. Cuticle annulated throughout length of body, deeply annulated upto the base of the pseudobulb from anterior end. Cephalic extremity formed by two annules. Head and first annule together 14.58-24.3 µm long, 26.73-36.45 µm wide. Lateral alae start from base of oesophagus and reach upto anus, do not terminate in spines. Mouth surrounded by 8 submedian papillae and 6 inner labial papillae, amphids present. Oesophageal corpus divided into anterior cylindrical part, 0.109 - 0.123 mm long, 0.017 - 0.021 mm wide; posterior part of corpus terminated by large ovoid pseudobulb, 0.072 - 0.099 mm long, 0.053 - 0.068 mm wide. The total length of corpus is 0.182 - 0.223 mm. Isthmus 0.034 - 0.051 mm long, 0.019 - 0.024 mm wide. Endbulb pyriform, 0.060 - 0.080 mm long, 0.070 - 0.087 mm wide. Cardia distinct. Nerve ring situated at 0.102 - 0.123 mm from anterior end. Excretory pore at 0.294 - 0.441 mm from anterior end. Gonads didelphic, prodelphic. Vagina and common uterus posteriorly directed. Vulva a small transverse slit in anterior part of the body posterior to base of the oesophagus. Eggs elongate, ellipsoidal. Tail long and filiform, having a cap-like structure at its tip. Anus situated at 1.423 - 2.325 mm from anterior end.

Male: Body small and has a truncated appearance, slightly curved ventrally at the posterior end upon fixation. Cuticle finely striated upto posterior region of

corpus from head end. Narrow lateral alae present. Oesophagus 0.116 - 0.145 mm long, devoid of pseudobulb. Corpus cylindrical, 0.063-0.072 mm long, 0.007 - 0.010 mm wide. Isthmus measures 0.036 - 0.048 mm in length, 0.007 - 0.009 mm in width. Endbulb ovate, 0.019 - 0.029 mm long, 0.019 - 0.024 mm wide. Buccal cavity 2.43 μm long, 4.86 μm wide. Nerve ring at 0.085 - 0.102 mm from anterior end. Excretory pore 0.136 - 0.179 mm from anterior end. Tail distinctly marked off from the body, filiform. Testes and spicule single. Caudal papillae 4 pairs, one pair subventral preanal, one pair adanal, one pair subventral just posterior to anus and one duplex papilla at the base of the caudal appendage.

Host : *Periplaneta americana*

Habitat : Posterior gut

Locality : Imphal, Manipur (North East India)

Remarks : The present specimens are in agreement with the description and range of measurements given by earlier workers except in slightly longer male tail and spicule (spicule = 20 - 25 μm and tail = 0.080 - 0.095 mm). The presence of a cap-like structure at the tip of tail in females is reported for the first time.

Key to species of *Hammerschmidtiella*

1. Male with crest or ridges behind anus..... *cristata* Spiridonov, 1984

- Multiple crest or ridges behind anus absent in male.....2

2(1). Presence of highly curved corpus over end bulb in female.....

..... *poinari* Gupta & Kaur, 1978

- Corpus not curved in female.....3

3(2). Vulva provided with 3 cuticularised plates ..... *basiri* Singh & Kaur, 1988

- Vulva without plates.....4

4(3). Caudal papillae and spicule present in male.....5

- Caudal papillae and spicule absent in male.....

..... *aspiculus* Biswas & Chakravarty, 1963

5(4). Spicule = 18 µm long.....6

- Spicule more than 18 µm long.....8

6(5). Female = 1.926 - 2.022 mm long..... *acreana* Kloss, 1966

- Female more than 2.022 mm long 7

7(6). Female = 2.20 - 3.77 mm and tail = 0.250-0.290; male = 0.520-0.560mm...

..... *mackenziei* (Zervos, 1987) Adamson & Waerebeke, 1992a

- Female = 3.0 - 3.33 mm and tail 0.78 mm; male = 0.81 - 0.96 mm.....

..... *manohari* Rao, 1958

8(5). Female = 1.81 mm long; spicule = 20 μm long..... *singhi* Rao& Rao,1965

- Female = more than 1.81 mm long; spicule = more than 20 μm long.....9

9(8). Male = 0.487 - 0.853 mm long.....

..... *diesingi* (Hammerschmidt, 1838) Chitwood, 1932

- Male = more than 0.853 mm long.....10

10(9). Caudal papillae in male = 5 pairs, gubernaculum = 14 - 18 μm long..... *andersoni* Adamson & Nasher, 1987

- Caudal papillae = 3 pairs, gubernaculum absent.....

..... *nayrai* Serrano Snchez, 1945.

TABLE-4
Comparative measurement chart of the species of genus *Hammerschmidtiella*

Characters	*H nayrai*	*H mackenziei*	*H manoharı*	*H aspiculus*	*H poınarı*	*H. basırı*	*H. andersoni*	*H. sınghı*	*H acreana*	*H cristata*	*H diesingi*
	mm*	**mm***	**mm***	**mm***	**mm***	**mm***	**mm***	**mm***	**mm***	**mm***	**mm**
Female											
Length	2 8	2 20-3 77	3 0-3 3	2 48-3 2	2 3-2 9	2 7-3 0	3-3 53	1 81	1 926-2 022		2 228-3 316
Width	0 285	0 26-0 56	0 15-0 18	0 24-0 28	-	0 29-0 30	0 141-0 188	0 164	0 193-0 215	- -	0 166-0 284
Oesoph	0 333	0 320-0 376	0 32-0 35	0 28-0 29	-	-	0 39-0 457	-	0 299-0 326	- -	0 285-0 344
N ring	0 080	-	-	0 24-0 28	0 128-0 182	0 09-0 10	0 132-0 160	-	0 075	- -	0 102-0 123
Exc pore	0 525	0 4-0 580	-	0 27-0 28	0 270-0 30	0 32-0 33	0 483-0 611	-	x		0 294-0 441
Vulva	0 90	0 780-1 240	-	0 57-0 67	Mid body	-	0 877-1 041	0 481	1 263-1 359-	- -	0 441-0 834
Egg	78x34µm	80x28µm	75-84x	74-78x	64-80x	90-100x	86-100x	-	75-78x	- -	72 9-80 19x
			38µm	40µm	45-48µm	40-50µm	32-43µm	-	25-29mm	- -	29 16-34 02µm
Tail	1/7th of BL	0 250-0 290	0 78	0 92-0 96	0 482-0 567	0 9-1 0	0.579-0.679	0.658	- -	- -	0 756-0 991
Corpus	0 120	0 220-0 270	0 147-0 168x	-	-	0 20-0 22	0 240-0.275x	0.094-0 016	- -	- -	0 182-0 223x
			0 016-0 018				0 054-0 061				0 017-0 068
Isthmus	0 06	0 020-0 030	0 052-0 063	-	0 068	0 16-0 17	0 073-0 099	0 037x 0 015	- -	- -	0 034-0 051
End bulb	0 055-0 070	0 070-0 090x	0 062-0 069w	0 080-0 09x	-x 0 068-	0 07-0 08	0 078-0.083x	- x 0 063w	- -	- -	0 060-0 080x
		0 1-0 12		0 08-0 09	0 082w		0 075-0.081				0 070-0 087
Pseudobulb	0 098-0 056	-	0 056-0 084x	0 08-0 09x	-	0 09-0 01	-	0 070-0 047	- -	- -	0 072-0 099x
			0 046-0 056	0 07-0 08							0 053-0 068

TRABLE-5
Comparative measurement chart of the species of the genus *Hammerschmidtiella*

Characters	*H. nayrai*	*H. mackenziei*	*H. manohari*	*H. aspiculus*	*H. poinari*	*H. basiri*	*H. andersoni*	*H. singhi*	*H. acreana*	*H. cristata*	*H. diesingi*
	mm*	mm*	mm*	mm*	mm*	mm*	mm*	mm*	mm*	mm*	mm
Male											
Length	1.27	0.520-0.560	0.81-0.96	2.54-2.7	-	-	1.11-1.44	0.83	0.590-0.710	0.671	0.487-0.853
Width	0.080	0.036	0.042	0.23-0.24	-	-	0.065-0.086	0.046	0.031-0.052	0.064	0.034-0.082
Oesoph.	0.146	0.068	0.12-0.131	0.41-0.46x 0.03	-	-	0.148-0.168	0.111	0.107-0.117	- -	0.116-0.145
N.ring	-	-	-	0.18-0.22	-	-	0.091-0.103	- -	- -	- -	0.085-0.102
Exc.pore	-	-	-	0.4-0.5	-	-	0.290-0.384	-	- -	- -	0.136-0.179
Corpus	-	-	0.055-0.067x 0.009-0.012	-	-	-	0.062-0.071	0.053-0.012	- -	- -	0.063-0.072x 0.007-0.010
Isthmus	0.050	-	0.036-0.042x 0.007	-	-	-	0.083-0.099	0.039-0.009	0.026-0.036	- -	0.036-0.048x 0.007-0.009
End bulb	0.025x0.025	0.014	0.03-0.035x 0.015-0.018	0.10-0.11x 0.11-0.12	-	-	0.026-0.029	-x0.022	0.018-0.026x 0.018	- -	0.019-0.029x 0.019-0.024
Pseudobulb	0.035 x 0.015	-	-	-	-	-	-	-	0.016-0.018x0.013-	-	
C. pap.	3pairs	4 pairs	4 pairs	absent	-	-	5 pairs	4 pairs	-	4 pairs	4 pairs
Spicule	28µm	18µm	18µm	absent	-	-	22-24µm	20µm	18µm	21.426µm	26.73-36.45µm
Tail	0.034	0.028	-	0.82-0.90	-	-	0.071-0.083	0.11	0.078x 0.135	0.078	0.104-0.148
Gubernac.	-	-	-	-	-	-	14-18µm	-	- -	- -	-

* All measurements from original descriptions

Abbreviations used : Oesoph. = Oesophagus, N.ring = Nerve ring, Exc.pore = Excretory pore, C.pap.= Caudal papillae, Gubernac.= Gubernaculum, w = width, BL=Body length

Genus *Cameronia* Basir, 1948a

Synonym: *Psilocephala* Rao, 1958.

Basir (1948a) erected the genus *Cameronia* with *C. biovata* as its type species based only on female specimens from the host *Gryllotalpa africana*. Kloss (1959d) reported the male of the type species from Brazil but from a different host *Scapteriscus tenuis*. Adamson & Waerebeke (1992a) while revising the family Thelastomatidae considered that the males described by Kloss probably belongs to the genus *Gryllophila*. Rao (1958) proposed the genus *Psilocephala* with *P. psilocephala* as its type species from South India, which is later synonymised with the genus *Cameronia* by Adamson and Waerebeke (1992a). Leibersperger (1960) described *C. multiovata* from *G. africana* from France. Farooqui (1968e,1970) described *C. travassosi* and *C. aspiculata* from *G. africana* from Maharastra, India. Parveen and Jairajpuri (1984b,1985a) described two species under the genus, namely *C. klossi* and *C. nisari* from North India. Rizvi & Jairajpuri (2002) described *C. basiri* from North India. Altogether 9 species have been described so far under the genus from different parts of the world out of which 7 species are reported from India alone. In the present study, two new species of the genus have been added to the existing 9 known species thereby bringing the total number of species to 11.

Generic diagnosis (emended)

Generic diagnosis has been emended in order to accommodate the two new species.

Female: Cephalic extremity formed by single annule and simple second annule. Oesophagus consisting of a cylindrical corpus, an isthmus which may be distinct or indistinct and a valvular bulb. Cardia lobed or simple. Vulva in the posterior third of body, vagina directed anteriorly. Gonads amphidelphic. Eggs elongate, elliptical, flattened on one side fused in pairs or more along their flattened surfaces with ridges and furrows or simply attached to one another forming a chain. Polar egg filaments present or absent. Tail conical or with a terminal spike.

Male: Cephalic extremity formed by single annule. Oesophagus consists of a cylindrical corpus, distinct or indistinct isthmus with a bulb. Spicule single or absent. Caudal papillae 3-5 pairs. Tail very short, rounded, with or without a spine like process on its ventral side.

Cameronia triovata n. sp.

(Fig. 5)

Dimension

Holotype female: a = 10.68, b = 7.25, c = 20.98, V = 74.34 , oesophagus = 0.324mm ; nerve ring = 0.149 mm; vulva = 1.747 mm, buccal cavity = 9.72 x 8.5µm , egg = 144.58 x 34.02 µm, 1st annule = 10.93 x 29.16 µm; head = 3.64 x 19.44 µm; corpus = 0.228 x 0.030 mm; isthmus = 0.017 x 0.026 mm ; valvular bulb = 0.077 x 0.078 mm, L = 2.350 mm, W = 0.220 mm,. excretory pore = 0.648 mm ; tail = 0.112 mm from anterior end.

Paratype females (n = 2)

a = 11.99 - 12.55 (12.27 ± 0.395); b = 7.88 - 8.32 (8.1 ± 0.311); c = 20.08 - 21.62 (20.85 ± 1.088); V = 71.38 - 73.76 (72.57 ± 1.682); L = 3.012 - 3.179 (3.0955 ± 0.118) mm; W = 0.240 - 0.265 (0.252 ± 0.017) mm; oesophagus = 0.382 mm; excretory pore = 0.721 - 0.746 (0.733 ± 0.176) mm; nerve ring = 0.182 - 0.191 (0.186 ± 0.006) mm; anus from anterior end = 2.862 - 3.032 (2.947 ± 0.120) mm; buccal cavity = 9.72 - 12.15 x 9.72 (10.935 ± 1.718 x 9.72) µm; eggs = 144.58 - 161.59 x 34.02 - 35.23 (154.91 ± 9.446 x 34.625 ± 0.855) µm; tail = 0.147 - 0.150 (0.148 ± 0.002) mm; vulva = 2.150 - 2.345 (2.247 ± 0.137) mm; corpus = 0.270 - 0.279 x 0.031 - 0.034 (0.274 ± 0.006 x 0.032 ± 0.002) mm; isthmus = 0.019x 0.029 mm; valvular bulb = 0.083 - 0.088 x 0.082 - 0.088 (0.085

± 0.003x 0.085 ± 0.004) mm; head = 2.43 - 6.07 x 15.79 - 23.08 (4.25 ± 2.573 x 19.435 ± 5.154) µm ; 1st annule = 10.93 x 29.16 µm.

Description

Male: Not found

Female : Female body 2.350 - 3.179 mm long ,0.220 - 0.265 mm wide, almost straight upon fixation. Cuticle annulated along the entire length, more pronounced in the anterior region. Mouth opening surrounded by circumoral elevation having eight labial papillae and a pair of amphids and a single expanded annule. Head annule measures 2.43 - 6.07 µm in length and 15.79 - 23.08 µm in width. Simple expanded second annule measures 10.93 x 29.16 µm. Buccal cavity short, 9.72 - 12.15 µm deep, 8.5 - 9.72 µm wide. Oesophagus 0.324 - 0.382 mm long, consisting of a cylindrical corpus measuring 0.228 - 0.279 mm in length and 0.030 - 0.034 mm in width; an isthmus measuring 0.017 - 0.019 mm long and 0.026 - 0.029 mm wide; and a posterior end bulb having 0.077 - 0.088 mm in length and 0.078 - 0.088 mm in width. Nerve ring and excretory pore situated at 0.149 - 0.191 mm and 0.648 - 0.746 mm from the head end. Vulva opens at 1.747-2.345 mm from the head end. Tail conical, 0.112 - 0.150 mm long. Gonads didelphic, amphidelphic. Vagina directed anteriorly. Eggs elongate, 144.58-161.59 µm long, 34.02 - 35.23 µm wide, elliptical in shape bearing two endings with polar filaments. Three eggs fused with ridges and furrows to one another along

their flattened surfaces, the attachment between eggs (three in number) is brought about by alternate arrangement of ridges and furrows.

Type Host : *Gryllotalpa africana*

Habitat : Intestine

Locality : Imphal, Manipur (North East India)

Type material: Holotype female on slide *Cameronia triovata* n.sp/12, paratype females on slides *C. triovata* n.sp./29,30 deposited in nematode collection of the Department of Zoology, Aligarh Muslim University, Aligarh (U.P), India.

Diagnosis and relationships

C. triovata n.sp. is characterized by a short buccal cavity; distinct isthmus; eggs fused provided with polar filaments in groups of three along the ridges and furrows and a short conical tail.

C. triovata n.sp. come close to *C. travassosi* Farooqui,1968 in having conical tail, eggs with ridges and furrows. However, it differs in having smaller length and width of body, shorter oesophagus, smaller tail, i.e. the position of vulva, excretory pore, nerve ring (L = 4.51- 6.66, W = 0.54 - 0.78, oesophagus = 0.46 - 0.59, excretory pore = 1.1 - 1.7 mm from anterior end, nerve ring = 0.24 - 0.27 mm from anterior end, tail = 0.16 - 0.22 mm long in *C. travassosi*). Further, it also differs in having polar egg filaments and 3 eggs laid at a time.

The new species resembles *C. klossi* Parveen & Jairajpuri,1984b in having conical tail, eggs with ridges. However, it differs from *C. klossi* in having longer body, shorter oesophagus, shorter tail, larger egg size and in the presence of polar filaments (L = 1.94 mm, oesophagus = 0.46 mm, tail = 0.204 mm, egg = 133 - 147 x 46 -49 in *C. klossi*). Further, in *C. triovata* 3 eggs are laid at a time as against 2 or single pair in *C. klossi.*

C. triovata n.sp. also resemble *C. biovata* Basir,1948 in body length, nerve ring, conical tail, ridges in eggs, but differs from *C. biovata* in having shorter oesophagus, in the position of excretory pore and in having larger eggs (Oesophagus = 0.440 - 0.465 mm, excretory pore = 0.5 mm from anterior end, egg = 130 x 50 μm in *C. biovta*). Polar egg filaments are lacking in *C. biovata* in which eggs are fused in pairs.

Cameronia manipurensis n. sp.

(Fig. 6)

Dimensions

Holotype female

a = 10.78; b = 5.80; c = 15.44; V = 63.50; L = 1.962 mm; W = 0.182 mm; 1st annule = 7.29 x 26.73µm; head = 4.86 x 18.22 µm; buccal cavity = 12.15 x 7.29 µm; corpus = 0.232 x 0.029 mm; isthmus = 0.019 x 0.026 mm; valvular bulb = 0.085 x 0.082 mm; oesophagus = 0.338 mm; excretory pore = 0.549 mm; nerve ring = 0.172 mm; tail = 0.127 mm; vulva = 1.246 mm; egg = 109.35 x 38.88 µm

Paratype females (n = 11)

a = 9.98 - 13.86 (11.365 ± 1.003); b = 5.33 - 6.18 (5.829 ± 0.284); c = 12.39 - 15.79 (14.734 ± 0.988); V = 61.51 - 65.35 (63.649 ± 1.353); L = 1.622 - 2.089 (1.971 ± 0.136) mm; W = 0.117- 0.196 (0.174 ± 0.022) mm; head annule = 2.43 -7.29 x 15.79 - 24.3 (3.754 ± 1.579 x 17.008 ± 2.549) µm; 1st annule = 4.86 - 7.29 x 21.87 - 26.73 (6.803 ± 0.850 x 24.905 ± 1.541) µm; buccal cavity = 9.72 - 18.84 x 7.29 - 7.53 (12.537 ± 2.213 x 7.311 ± 0.072) µm ; corpus = 0.211 - 0.245 x 0.023 - 0.029 (0.230 ± 0.010 x 0.0278 ± 0.001) mm; isthmus = 0.017 - 0.024 x 0.017 - 0.026 (0.0207 ± 0.002 x 0.0235 ± 0.002) mm; valvular bulb = 0.068 - 0.083 x 0.060 - 0.085 (0.080 ± 0.004 x 0.077 ± 0.006) mm; oesophagus = 0.304 - 0.353 (0.338 ± 0.012) mm; nerve ring = 0.160 - 0.186 (0.174 ± 0.007)

mm ; excretory pore = 0.491 - 0.579 (0.543 ± 0.022) mm ; vulva = 1.060 - 1.325 (1.253 ± 0.077) mm ; eggs = 102.06 -109.35 x 32.80 - 38.88 (106.477 ± 2.191 x 37.885 ± 1.946) µm; tail = 0.117 - 0.166(0.137 ± 0.014) mm

Paratype males (n = 8)

a = 8.23 - 11.87 (10.342 ± 1.481); b = 5.26 - 5.89 (5.427 ± 0.322); L = 0.707 - 0.914 (0.807 ± 0.076) mm; W = 0.068 - 0.088 (0.078 ± 0.007) mm; buccal cavity = 4.71 - 5.65 x 4.71 - 6.59 (4.827 ± 0.332 x 6.002 ± 0.861) µm; oesophagus = 0.133 - 0.162 (0.148 ± 0.009) mm; spicule = 10.36 - 13.18 (12.475 ± 1.305) µm.

Description

Female: Body medium sized, 1.622 - 2.089 mm long, 0.117 - 0.196 mm wide, almost straight to slightly curved upon fixation. Cephalic extremity formed by single annule measuring 2.43 - 7.29 µm in length and 14.58 - 24.3 µm in width and simple expanded second annule measuring 4.86 - 7.29 µm in length and 21.87 - 26.73 µm in width. Mouth opening surrounded by eight labiopapillae and amphids. Buccal cavity 12.15 - 18.84 µm long, 7.29 - 7.53 µm wide. Oesophagus 0.304 - 0.353 mm long having a cylindrical corpus measuring 0.211 - 0.245 mm in length and 0.023 - 0.029 mm in width, distinct isthmus measuring 0.017 - 0.024 mm in length and 0.017 - 0.026 mm in width and an end bulb which is spherical and measures 0.068 - 0.085 mm in length and 0.060 - 0.085 mm in

diameter. Annulation prominent only in the cervical region and extends upto the base of the level of end bulb. The nerve ring is located 0.160 - 0.186 mm from the anterior end. The excretory pore lies behind the end bulb at 0.491 - 0.579 mm from the head end. Gonads two i.e., didelphic, amphidelphic. Eggs 102.06 - 109.35 μm long, 32.80 - 38.88 μm wide, attached to one another. Vagina directed anteriorly. The vulva opens at 1.060 - 1.325 mm from the anterior end. Tail conical and measures 0.117 - 0.166 mm.

Male: Small, curved ventrally at the posterior region upon fixation. Cephalic extremity formed by single annule. Annulation present throughout the entire length. Lateral alae present from midbody to the posterior end. Excretory pore prominent and is situated posterior to the base of the oesophagus at 0.190 - 0.305 mm from head end. Nerve ring encircles the corpus at 0.092 - 0.116 mm from the anterior end. Oesophageal corpus measures 0.092 - 0.114 mm in length and 0.012 - 0.013 in width. Isthmus very short and measures 0.007 - 0.012 mm in length and 0.009 - 0.012 mm in width. Endbulb spherical, 0.031 - 0.036 mm long and 0.029 - 0.034 mm wide. Testis single reflexed anteriorly some distance away behind the oesophageal bulb. Tail truncated. Spine like process at the tail is lacking. Caudal papillae consist of three pairs of which one pair preanal and 2 pairs postanal. Spicule long and whip-like. Anus subterminal.

Type host : *Gryllotalpa africana*

Habitat : *Intestine*

Locality : Imphal, Manipur (North East India)

Type material: Holotype female on slide *Cameronia manipurensis* n.sp./21, paratype females on slides *C. manipurensis* n.sp./13,16,17, 18, 20, 22, 23, 24, 25, 26, 27; paratype males on slides *C. manipurensis* n.sp./2,3,4,5,6,7,9,10, deposited in the nematode collection of the Department of Zoology, Aligarh Muslim University, Aligarh, U.P., India.

Diagnosis and relationships

Female *C. manipurensis* n.sp. is characterized by eggs arranged one upon another but not end to end in a group of five or more. The male is characterized by having 3 pairs of caudal papillae without spine-like process at the tail region.

The new species comes close to the type species type species *C. multiovata* Leibersperger,1960 in having elliptical eggs and a conical tail but differs in having different body dimension (L = 2.93 - 4.59 mm, W = 0.26 - 0.47mm , oesophagus = 0.40 - 0.52 mm, excretory pore = 0.80 - 1.16 mm, nerve ring = 0.21 - 0.28 mm, egg = 128 - 152 x 43 - 50 μm, tail = 0.23 - 0.35 mm and in the arrangement of eggs, i.e. more than 2 eggs attached end to end in *C. multiovata*).

Male of *C. manipurensis* n.sp. resembles male of *C. multiovata* in the presence of three pairs of caudal papillae and in the shape of its tail however, it differs from *C. multiovata* in having a shorter body length, width, in the length of oesophagus, in position of excretory pore and spicule (L = 1.37 - 1.68 mm, W = 0.10 - 0.14 mm, oesophagus = 0.193 - 0.24 mm, excretory pore = 0.43 - 0.56 mm

from anterior end, spicule = 24 - 27 μm and in the presence of a spine-like process at the tip of tail in *C. multiovata*).

C. manipurensis n.sp. also differs from *C. laplatae* Reboredo & Camino, 2001 in having shorter males and females, shorter spicule (Female = 4.040 - 4.460 mm, male = 2.160 - 2.270 mm , spicule = 32.9 - 35.25 μm in *C. laplatae*).

Key to species of *Cameronia*

1. Male = less than 2.160 mm long; oesophagus = less than 0.564 mm long in female.....2
- Male = 2.160 – 2.270 mm long; oesophagus = 0.564 – 0.644 mm long in female..... *laplatae* Reboredo & Camino, 2001

2(1). Spicule present.....3
- Spicule absent.... *aspiculata*(Farooqui,1970)Adamson & Waerebeke,1992

3(2). Female tail conical.....4
- Female tail with a terminal spike.....
.....*psilocephala* (Rao,1958) Adamson & Waerebeke,1992

4(3). Eggs laid fused.....5
- Eggs laid singly.....8

5(4). Two eggs fused.....6
- More than two eggs fused.....9

6(5). Two eggs fused and distinctly ridged.....7

- Two eggs fused and not ridged..... *biovata* Basir,1948a

7(6). Spicule 32 μm long..... *klossi* Parveen & Jairajpuri,1984

- Spicule 38 - 43 μm long..... *travassosi* Farooqui 1968e

8(4). Lobed cardia present and V = 75 - 80%..... *basiri* Rizvi & Jairajpuri,2002

- Lobed cardia absent and V = 62 - 63%.....
..... *nisari* (Parveen & Jairajpuri,1985)Adamson & Waerebeke,1992

9(5). Three eggs fused, ridged and polar filaments present..... *triovata* n.sp.

- More than three eggs fused end to end, not ridged and polar filaments absent.....10

10(9). Male tail with a thorn-like process on its ventral side and spicule = 24 – 27μm *multiovata*Leibersperger,1960

- Male tail without a thorn like process and spicule=10.36-13.18 μm ... ... *manipurensis* n.sp.

TABLE-6
Comparative measurement chart of the species of genus *Cameronia*

Characters	*C.biovata* (mm*)	*C.aspiculata* (mm*)	*C.multiovata* (mm*)	*C.nisari* (mm*)	*C.psilocephala* (mm*)	*C.travassosi* (mm*)	*C.klossi* (mm*)	*C.basiri* (mm*)	*C.triovata* n.sp. (mm)	*C.laplatae* (mm*)	*C.manipurensis* n.sp. (mm)
Female											
Length	2.35-2.50	1.61-2.09	2.93-4.59	1.6-1.79	2.742-2.80	4.51-6.66	1.94	3.05-4.66	2.350-3.179	4.040-4.460	1.622-2.089
Width	0.4	0.16-0.26	0.26-0.47	0.16-0.165	0.3-0.33	0.54-0.78	0.27	-	0.220-0.265	-	0.117-0.196
Oesophagus	0.440-0.465	0.28-0.32	0.40-0.52	0.29-0.33	0.418	0.46-0.59	0.46	0.39-0.49	0.324-0.382	0.564-0.644	0.304-0.353
Excretory pore	0.5	0.45-0.54	0.80-1.16	-	-	1.1-1.7	0.61	0.89-0.94	0.648-0.746	0.928-1.032	0.491-0.579
Nerve ring	0.20	0.19-0.29	0.21-0.28	-	-	0.24-0.27	0.19	0.13-0.2	0.149-0.191	-	0.160-0.186
Vulva	1.7	0.99-1.29	1.07-1.71	1-1.11	1.72	3.38-5.11	1.36	-	1.747-2.345	-	1.060-1.325
%V	72	-	-	62-64.07	-	-	70	75.5-79.58	71.38-74.34	80.69-87.44	61.51-65.35
Egg	130x50µ	102-105x	128-152x	111-126x	102-108x	-	133-147x	100-112x	144.58-161.69	96-110 x	102.06-109.35
		34-44µm	43-50µm	39-43µm	60-64µm		46-49µm	39-48µm	34.02-35.23µm	36-40µm	32.80-38.88µ m
Tail	-	0.12-0.15	0.23-0.35	0.11-0.13	0.10	0.16-0.22	0.204	0.14-0.15	0.112-0.150	0.036-0.044	0.117-0.166
Male											
Length	-	0.86	1.37-1.68	0.73-0.83	1.04	0.88-0.9	0.69	0.97	-	2.160-2.270	0.707-0.914
Width	-	0.08	0.10-0.14	0.06-0.07	0.11	0.094-0.099	0.06	-	-	-	0.068-0.088
Oesophagus	-	0.22	0.193-0.24	0.134-0.143	0.14	0.14-0.16	0.144	0.152	-	0.230-0.244	0.133-0.162
Excretory pore	-	-	0.43-0.56	0.27-0.35	-	0.30-0.31	0.28	-	-	0.284-0.305	0.190-0.305
Nerve ring	-	0.079	-	0.066-0.070	-	0.053-0.061	0.061	0.099	-	-	0.092-0.116
Tail	-	0.015	0.019-0.023	0.011-0.015	-	0.078-0.08	0.052	-	-	0.016-0.025	-
Spicule	-	absent	24-27µm	19-22µm	30µm	38-43µm	32µm	19µm	-	32.9-35.25µm	10.36-13.18µm
Caudal papillae	-	3pairs	3pairs	3pairs	3pairs	5pairs	4pairs	3pairs	-	4pairs	3pairs

*All measurements from original descriptions

CHAPTER – II

Family **Travassosinematidae** Rao, 1958

Synonyms

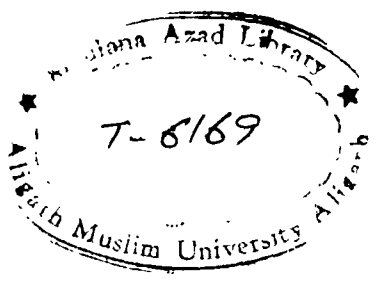
Chitwoodiellidae Kloss
Pulchrocephalidae Kloss

Rao (1958) proposed the family Travassosinematidae for three genera namely *Pulchrocephala* Travassos, 1925a, *Indiana* Chakravarty, 1943 and *Travassosinema* Rao, 1958 which were characterized by cephalic cuticular modifications for which Hunt (1981 , 1983) coined the term cephalic umbraculum. Kloss(1960) proposed two families namely Pulchrocephalidae and Chitwoodiellidae in which the former is represented by the genera *Pulchrocephala* Travassos, 1925a, *Indiana* Chakravarty, 1943 and *Pteronemella* Rao, 1958 while the later by *Mirzaiella* Basir, 1942, *Chitwoodiella* Basir, 1948 and *Singhiella* Rao, 1958. Skrjabin *et al.*, (1966) and Poinar (1977a) did not recognise the family Travassosinematidae, but accepted the two families of Kloss, i.e. Pulchrocephalidae and Chitwoodiellidae as two distinct families and transferred the type genus *Travassosinema* to the family Thelastomatidae based on the presence of spicule which was lacking in the other two genera of Travassosinematidae. Adamson (1987b) found Rao's (1958) family monophyletic but cautioned against its use because of the confusion it would create with respect to taxonomic placement of such genera as *Binema, Mirzaiella* and *Chitwoodiella* which are clearly related to *Pulchrocephala* and *Indiana* but have little in common

with *Travassosinema*. Adamson & Waerebeke(1992b) revised the family Travassosinematidae and combined it with Chitwoodiellidae and Pulchroceplahidae Kloss(1960)and two more genera, i.e., *Binema* Travassos, 1925b and *Isobinema* Rao,1958 have been added. In the present study we follow the views of Adamson and Waerebeke (1992b). During the present investigation, some members of the family, namely *Chitwoodiella*, *Binema* and *Mirzaiella* have been collected and described.

Diagnosis

Cephalic extremity simple or formed by 6-12 hood-like expansion. Mouth surrounded by 3-8 labial papillae. Lateral alae present or absent. Oesophagus consisting of cylindrical or clavate corpus, isthmus distinct or just a constriction between corpus and a posterior endbulb. Vulva posterior to midbody. Gonads amphidelphic. Eggs with polar filaments and not twisted around shell. Males with single testes. Spicule single or absent. Caudal papillae 2-9 pairs or completely absent.



Key to genera of Travassosinematidae

1. Spicule present.....*Isobinema* Rao, 1958

- Spicule absent.....2

2(1). Buccal cavity annulated.....*Chitwoodiella* Basir, 1948

- Buccal cavity not annulated.....3

3(2). 2-5 pairs of caudal papillae in male.....4

- 9-10 pairs of caudal papillae in male.....*Pteronemella* Rao, 1958

4(3). Vulva posterior to midbody.....5

- Vulva at 2/3 of body length.....*Mirzaiella* Basir, 1942

5(4). Female tail with a spike-like caudal appendage.....6

- Female tail without a spike-like caudal appendage.. *Binema* Travassos, 1925

6(5). Spines present on the body of female.....*Indiana* Chakravarty, 1943

- Spines absent on body of female 7

7(6). Cephalic extremity provided with 6-12 hood-like projections 8

- Cephalic extremity simple, without hood-like projections.....

.....*Mohibiella* Farooqui, 1970

8(7). Eggs with polar filaments.....9

- Eggs without polar filaments.....*Travassosinema* Rao, 1958

9(8). Mouth with 6 lips, buccal cavity divided into 2 parts, a narrow and a broad posterior chamber occupied by leaf-like plates.....*Singhiella* Rao, 1958

Mouth with 12 hood-like formations arranged in 2 circles of 6, in tandem, buccal cavity not divided into two parts.....*Pulchrocephala* Travassos, 1925

Genus *Chitwoodiella* Basir, 1948b

Basir (1948b) established the genus *Chitwoodiella* with its type species *Chitwoodiella ovofilamenta* based only on female worms collected from *Gryllotalpa africana*. He placed this genus in the family Thelastomatidae as he observed 8 cephalic papillae. Later (1949) he obtained some type species from British West Indies consisting of both males and females from another host *Scapteriscus vicinus* of the family Gryllidae. He observed 4 cephalic papillae in both sexes and transferred this genus to the family Oxyuridae. Rao(1958) reported the type species from South India. Travassos (1953) reported a new species *Chitwoodiella thapari* from *Gryllotalpa* sp. from Brazil. Kloss (1959c) recorded the same species from *Gryllotalpa hexadactyla* from various Brazilian localities and considered *C. thapari* a synonym of the type species. However, Adamson and Waerebeke (1992b) considered it as a separate species based on geographical and host distribution. In the present study, we also maintain the synonymy of *C. thapari* with type species as claimed by Kloss. Parveen & Jairajpuri (1984a) reported the type species and another new species, *C. neoformis* from North India. Rizvi *et al.*,(1998) described *Chitwoodiella tridentata* from *Gryllotalpa africana* from North India. Adamson & Waerebeke (1992b) during revision of the superfamily Thelastomatoidea placed this genus in the family Travassosinematidae Rao, 1958 and in the present study we also maintain the same. At present the genus includes three species. The diagnosis of the genus is

emended to include some characters that were not mentioned earlier. During the present investigation several worms belonging to the type species were collected and reported for the first time from North East India.

Diagnosis (emended)

Female : Cephalic extremity formed by single lip cone. Buccal capsule long, tubular with striated cuticular wall, posterior part of which may or may not possess three cuticularised tooth like structures. Oesophageal corpus cylindrical. Cardia distinct and modified into a long tube directed posteriorly. Vulva between middle and posterior-third of body. Vagina short and directed anteriorly. Gonads amphidelphic. Blind ends of ovaries reflexed and reaching the oesophageal region. Eggs attached to one another in strings by polar filaments. Tail conical.

Male: Buccal capsule long tubular with striated cuticular wall, posterior part do not possess cuticularised tooth-like structures. Lateral alae present. Tail very short, truncated with cauldal alae. Spicule absent. Caudal papillae 5-6 pairs. A median ventral rod-like bluntly pointed projection juts out backwardly just behind the anus.

Chitwoodiella ovofilamenta Basir,1948b

(Fig. 7)

Dimensions

Females (n = 13)

a = 8.06 - 11.52 (9.889 ± 1.149); b = 4.08 - 5.83 (5.106 ± 0.482) ; c = 5.23 - 7.58 (5.903 ± 0.635); V = 55.78 - 61.34 (58.121 ± 1.665); L = 1.904 - 2.806 (2.398 ± 0.236) mm; W = 0.176 - 0.314 (0.245 ± 0.040) mm; oesophagus = 0.417 - 0.5 (0.469 ± 0.019) mm; eggs = 70.47 - 82.62 x 36.45 - 38.88 (75.813 ± 3.217 x 37.758 ± 1.260) μm; tail = 0.304 - 0.451 (0.404 ± 0.0593) mm.

Males (n = 3)

a = 9.07 - 10.15 (9.689 ± 0.557); b = 4.013 - 4.84 (4.521 ± 0.444); c = 53.291 - 66.7 (60.557 ± 6.774); L = 1.172 - 1.334 (1.2616 ± 0.0823) mm; W = 0.119 - 0.147 (0.1306 ± 0.0145) mm; oesophagus = 0.264 - 0.292 (0.279 ± 0.0142) mm; buccal cavity = 26.73 - 31.59 (29.16 ± 2.43) x (Maximum 9.72 μm / Minimum 7.29 μm).

Description

Female: Body slightly curved upon fixation. Annules prominent in cervical region. Lateral alae absent. Mouth opening subtriangular surrounded by circumoral elevation bearing 3 distinct small lips, the dorsal lip with two minute subdorsal papillae and each venterolateral lip with one subventral papilla and one

amphid. Buccal cavity 36.45 - 48.6 μm long with striated cuticular wall and width of 9.72-17.01μm, the anterior half being narrower and finely striated and the posterior half wider with few striations. Oesophageal corpus cylindrical, 0.314 - 0.387 mm long and 0.024 - 0.029 mm wide. Isthmus distinct, 0.019 - 0.034 mm long, 0.019 - 0.024 mm wide. End bulb ovate, 0.078 -0.088 mm long, 0.078 - 0.093 mm wide. Cardia distinct and modified into a long tubular structure. Nerve ring at 0.186-0.206 mm from anterior end. Excretory pore not distinct. Gonads amphidelphic. Vulva slightly behind midbody, 1.246 - 1.609 mm from anterior end. Vulval lip prominent antrior lip projecting outward. Vagina short and directed anteriorly. Ovaries reflexed and reach the oesophageal region a little behind the nerve ring. Eggs elliptical, attached to one another in strings held together by polar filaments. Tail attenuated, filiform.

Male : Worms small. Posterior end curved ventrally upon fixation. Cuticle annulated, distinct in the cervical region. Lateral alae present. Mouth opening subtriangular with 3 small lips. Head annule 8.5 μm long, 12.15 μm wide. Buccal cavity long and tubular with striated cuticular walls. Oesophageal corpus 0.196 - 0.218 mm long, 0.021 - 0.024 mm wide. Isthmus distinct, 0.017 - 0.021 mm long, 0.012 - 0.014 mm wide. Endbulb ovate, 0.051 - 0.053 mm long, 0.048 - 0.051 mm wide. Nerve ring at 0.165 - 0.172 mm from anterior end. Testes single, reflexed posteriorly behind the base of the oesophageal bulb at 0.140 - 0.177 mm. Tail very

short, truncated with distinct caudal alae, 0.019 -0.024 mm long. Caudal papillae 5 pairs, of which 3 pairs are preanal and two pairs post anal, both the latter pairs are distinctly pedunculated. One of the 3 preanal papillae is ventral in position, second pair is lateral and third pair ventral. Spicule absent. Rod like bluntly pointed projection on tail 17.01μm long.

Host : *Gryllotalpa africana*

Habitat : Mid gut

Locality : Imphal, Manipur (North East India)

Remarks : The present specimens conform well with the measurements and description of *C. ovofilamenta* given by earlier workers except in having slightly longer male tail, shorter rod-like projection and in position of nerve ring in male (Nerve ring = 0.145 mm, tail = 0.034 mm and rod-like projection = 18 μm). Presence of highly modified cardia into a long tubular structure in female and lateral alae in male has been reported for the first time.

Key to species of *Chitwoodiella*

1. 6 pairs of caudal papillae in male; female buccal cavity with 3 tooth-like structure ..... *tridentata* Rizvi *et al.*, 1998

\- 5 pairs of caudal papillae in male; female buccal cavity without 3 tooth-like structure.....2

2(1). Male = 1.172 - 1.334 mm; female = 1.904 - 2.806 mm, vulva = 1.246 - 1.609 mm..... *ovofilamenta* Basir, 1948b

- Male = 0.96 mm; female = 1.9-2.0 mm, vulva = 1.1-1.2 mm
  ..... *neoformis* Parveen &Jairajpuri, 1984a

TABLE-7

Comparative measurement chart of the species of genus *Chitwoodiella*

	C. neoformis	*C. tridentata*	*C. ovofilamenta*
Characters			
Female	**(mm*)**	**(mm*)**	**(mm)**
Length	1.9 - 2.0	2.07 - 2.88	1.904 - 2.806
Width	0.16 - 0.17	0.25 - 0.31	0.176 - 0.314
Oesophagus	0.46 - 0.47	0.432 - 0.478	0.176 - 0.314
Nerve ring	0.17 - 0.18	0.20 - 0.24	0.186 - 0.206
Tail	0.33 - 0.36	0.36 - 0.42	0.304 - 0.451
Vulva	1.1 - 1.2	1.08 - 1.54	1.246 - 1.609
Egg	75 - 83 x	69 - 71 x	70.47 - 82.62 x
	32 - 43 µm	34 - 50 µm	36.45 - 38.88 µm
Male			
Length	0.96	1.5 - 1.59	1.172 - 1.334
Width	0.086	0.12 - 0.16	0.119 - 0.147
Oesophagus	0.26	0.28 - 0.30	0.264 - 0.292
Nerve ring	0.15	0.15 - 0.17	0.165 - 0.172
Tail	0.015	0.014	0.019 - 0.024
Caudal papillae	5 pairs	6 pairs	5 pairs
Rod like projection	15 µm	12.5 – 15 µm	17.01 µm
Lateral alae	present	present	present

*All measurements from original descriptions

Genus ***Binema*** Travassos, 1925b

The genus *Binema* was erected by Travassos (1925b) to accommodate two species namely *B. binema* and *B. ornata* and provisionally placed in the superfamily Oxyuroidea along with parasites of Myriapodes. Later, Travassos (1929) transferred the genus to the family Thelastomatidae proposed by him. Chitwood (1932,1933) also placed the genus in the same family. Basir (1956) revised the genus and redescribed all the three valid species *viz.*, *Binema korsakowi*, *B. ornata* and *B. mirzaia.*

Rao (1958) reported these species from South India and described the males of *B. korsakowi* and *B. mirzaia* for the first time. Leibersperger (1960) reported *B. pseudornatum* from France based on females only.

Farooqui (1968b) established that the males of *B. ornata* described by Travassos (1925b) were in fact the males of *B. korsakowi* as he collected these males eight times along with females of the type species from *Gryllotalpa africana.* Parveen and Jairajpuri (1985b) reported a new species *B. parva* from North India. Rizvi and Jairajpuri (2000a) described a new species *B. striati* from North India. Adamson and Waerebeke (1992b) while revising the superfamily Thelastomatoidea transferred the genus *Binema* from family Thelastomatidae to family Travassosinematidae, Rao 1958.Camino and Reboredo (1999) reported a new species *B. bonaerensis* from Argentina.

Several worms were collected during the present study and some of them were found to belong to *B. ornata, B. mirzaia* and *B. korsakowi* while some were found to be different and could not be fitted to any of the known species and hence regarded as new species and described as *B. manipurensis* n.sp. At present the genus includes 8 species from all over the world.

Generic diagnosis (emended)

Cephalic extremity formed by a circumoral ring and short second annule. Lateral alae present or absent in both sexes. Isthmus distinct or it is a constriction between corpus and bulb with or without a ring-like sub-ganglion at its middle of isthmus. Buccal cavity absent or present in females. Vulva posterior to midbody. Gonads amphidelphic. Eggs broadly oval with polar filaments deposited in capsules containing 2-3 eggs or non-encapsulated and laid in pairs. Tail conical or rounded with short or long caudal appendage or flagella-like, with or without fine striations near its tips. Caudal extremity in male conical to subulate or filiform or spike-like. Caudal papillae 5 - 10 pairs. Single median papilla present or absent. Spicule single or absent.

Binema ornata Travassos, 1925b

(Fig. 8)

Dimensions

Females (n = 12)

a = 11.41 - 15.76 (13.865 ± 1.472); b = 6.43 - 10.59 (8.765 ± 1.209); c = 23.89 - 35.04 (28.95 ± 3.414); V = 55.15 - 62.22 (59.75 ± 1.985); L = 2.208 - 3.562 (2.939 ± 0.385) mm; W = 0.147 - 0.284 (0.214 ± 0.040) mm; oesophagus = 0.294 -0.368 (0.335 ± 0.018) mm; eggs = 51.03 - 60.75 x 26.73 - 29.16 (53.15 ± 2.648 x 27.43 ± 1.093) μm; tail = 0.088 - 0.108 (0.101 ± 0.008) mm.

Males (n = 3)

a = 9.85 - 12.03 (10.57 ± 1.258); b = 4.97 - 5.25 (5.086 ± 0.145); c = 13.63 - 24.89 (17.793 ± 6.176); L = 0.722 - 0.966 (0.835 ± 0.122) mm; W = 0.060 - 0.098 (0.080 ± 0.019) mm; oesophagus = 0.145 - 0.184 (0.163 ± 0.019) mm; tail = 0.029 - 0.065 (0.0513 ± 0.019) mm ; spicule = 34.02 - 46.17(42.12 ± 7.014) μm.

Description

Female: Cephalic extremity formed by single circumoral annule measuring 7.29 - 12.15 μm in length and 26.73 - 29.16 μm in width. Oral opening subtriangular, surrounded by 8 labial papillae and a pair of amphids. No striations on the body

except few at the tail region. Lateral alae conspicuous throughout the whole length of the body. Buccal cavity 4.86 - 7.29 μm long, 14.48 μm wide, partly surrounded by the esophagus, its walls presenting ornamentations which appear as striations or lateral thickenings or projections. Oesophagus comparatively short, consisting of a cylindrical corpus, 0.218 - 0.268 mm long by 0.034 - 0.042 mm wide, an isthmus 0.017 - 0.024 mm long by 0.026 - 0.034 mm wide. End bulb 0.065 - 0.075 mm long, 0.075 - 0.087 mm wide. Nerve ring at about the middle of corpus, 0.137 - 0.157 mm from anterior end. Excretory pore posterior to base of the esophagus, 0.461 - 0.579 mm from anterior end. Vulva situated at 1.374 - 2.061 mm from anterior end. Ovaries two, one anterior and the other posterior both reflexed. Vagina anteriorly directed. Eggs bear bunch of filaments at each pole joining one another, laid in capsule, each capsule usually containing two eggs. Tail very short, conical, ending in a minute caudal appendage.

Male: Body small, curved ventrally at the posterior region upon fixation. Cuticle annulated. Lateral alae absent. Head annule absent. Mouth surrounded by 8 labial papillae and a pair of amphids. Buccal cavity 4.86 μm long, 4.86 μm wide. Corpus cylindrical, tapering at both extremities, 0.094 - 0.121 mm long, 0.012 - 0.014 mm wide. Isthmus comparatively long, 0.021 - 0.026 mm long by 0.009 - 0.012 mm wide. Endbulb spherical. 0.029 - 0.036 mm long, 0.029 - 0.036 mm wide. Nerve

ring not visible. Excretory pore at 0.259 - 0.353 mm from anterior end. Tail conical. Caudal papillae 6 pairs, 3 pairs postanal, 1 pair adanal, 2 pair preanal in which one pair is comparatively larger and pedunculated.

Host : *Gryllotalpa africana*

Habitat: Intestine

Locality: Imphal, Manipur (North East India)

Remarks: The present specimens are in agreement with the measurements and descriptions given by earlier workers except in having slightly longer male, longer spicule (Male = 0.670 mm long, spicule = 20 μm long). Basir (1956) reported 5 pairs of caudal papillae in the present species in which 3 pairs are preanal and 2 pairs postanal. Camino & Reboredo (1999) mentioned 8 pairs of caudal papillae in *B. ornata* in which 4 pairs are prenal and 4 pairs postanal. In the present study 6 pairs of caudal papillae has been recorded.

Binema korsakowi (Sergiev, 1923) Basir,1956

(Fig. 9)

Dimensions

Males (n = 3)

a = 8.65 - 10.48 (9.41 ± 0.953); b = 4.43 - 5.20 (4.813 ± 0.385); c = 7.91 - 12.68 (10.103 ± 2.407); L = 0.710 - 0.807 (0.75 ± 0.050); W = 0.077 - 0.085 (0.08 ± 0.004); oesophagus = 0.153 - 0.160 (0.156 ± 0.003); tail = 0.058 - 0.102 (0.077 ± 0.022) mm; spicule = 36.45 - 41.31 (38.07 ± 2.805) μm.

Females (n = 4)

a = 8.71 - 10.46 (9.63 ± 0.726); b = 4.38 - 4.98 (4.717 ± 0.251); c = 9.27 - 11.43 (10.44 ± 0.895); V = 61.56 - 65.59 (63.56 ± 1.686); L = 1.539 - 1.796 (1.675 ± 0.112) mm; W = 0.147 - 0.206 (0.175 ± 0.024) mm; oesophagus = 0.309 - 0.373 (0.355 ± 0.031) mm; eggs = 51.03 - 53.46 x 29.16 (52.245 ± 1.718 x 29.16) μm; tail = 0.157 - 0.166 (0.1605 ± 0.004) mm.

Description

Male: Body small, curved ventrally at the posterior region upon fixation. Cuticle finely striated throughout body length. Mouth surrounded by 8 labial papillae and a pair of amphids. Buccal cavity small. Corpus cylindrical, 0.104 -0.106 mm long, 0.012 - 0.014 mm wide. Isthmus short, 0.009 - 0.012 mm long, 0.009 - 0.010 mm wide. End bulb oval, 0.036 - 0.08 mm long, 0.036 mm wide. Excretory pore post - oesophageal, 0.235 - 0.262 mm from head end. Tail abruptly narrows behind the

anus to form a spine-like ending or caudal spike. Caudal papillae nine pairs and a single median papilla, of which 4 pairs are preanal, one pair adanal and 4 pairs postanal and a single median papilla at the base of the caudal appendage. Testes single, reflexed at tip. Spicule single.

Female: Body more or less spindle-shaped with its maximum width at the centre, narrowing towards the extremities. Cuticle annulated but more pronounced at the anterior extremity. Lateral alae absent. Mouth surrounded by 8 labial papillae and a pair of amphids. Buccal cavity absent. Corpus cylindrical tapering anteriorly, 0.225 - 0.281 mm long, 0.030 - 0.034 mm wide. Isthmus indistinct. Endbulb spherical, 0.077 - 0.089 mm long, 0.080 - 0.089 mm wide. Nerve ring is located at 0.127 - 0.137 mm from head end. Excretory pore posterior to base of end bulb, 0.392 - 0.422 mm from head end. Cardia distinct. Vulva posterior to midbody, 0.971 - 1.178 mm from anterior end. Gonads didelphic, amphidelphic, one anterior and the other posterior, both reflexed at tips. Vagina directed anteriorly. Eggs broadly oval, with polar filaments, deposited in capsule containing 2 - 3 eggs. Eggs shell provided with spine-like outgrowths. Tail narrows gradually into a conical form.

Host : *Gryllotalpa africana*

Habitat : Intestine

Locality : Imphal, Manipur (North East India)

Remarks: The present specimens are in agreement with the range of measurements and diagrams given by earlier workers except in having slightly shorter female tail, oesophagus and in the position of excretory pore, nerve ring and vulva (Female = 2.08 - 2.12 mm, oesophagus = 0.4 - 0.42mm , excretory pore = 0.51 – 0.53 mm, nerve ring = 0.14 - 0.16 mm, vulva = 0.24 - 0.28 mm, tail = 0. 24 - 0.28 mm)

Binema mirzaia (Basir, 1942) Basir,1956

(Fig. 10)

Dimensions

Females (n = 10)

a = 11.26 - 15.33 (13.11 ± 1.444); b = 5.04 - 7.54 (6.34 ± 0.809); c = 27.92 - 53.38 (39.12 ± 7.78); V = 69.05 - 71.06 (69.68 ± 0.958); L = 2.178 - 3.689 (2.971 ± 0.509) mm; W = 0.142 - 0.304 (0.230 ± 0.054) mm; oesophagus = 0.432 - 0.5 (0.465 ± 0.024) mm; eggs = 43.74 - 59.53 x 26.73 - 31.59 (51.88 ± 4.20 x 29.08 ± 1.859) µm; tail = 0.068 - 0.088 (0.0466 ± 0.0058) mm.

Males (n = 8)

a = 7.57 - 11.68 (10.23 ± 1.411); b = 4.57 - 6.49 (5.87 ± 0.643); c = 14.11 - 34.28 (25.171 ± 5.892); L = 0.508 - 0.818 (0.702 ± 0.087) mm; W = 0.058 - 0.092 (0.069 ± 0.010) mm; oesophagus = 0.111 - 0.133 (0.119 ± 0.007) mm ; tail = 0.021 - 0.036 (0.028 ± 0.005) mm; spicule = 29.16 - 38.88 (33.41 ± 3.374) µm.

Description

Female: Body small, cylindrical in shape, attenuated at both ends. Lateral alae present throughout the length. Mouth surrounded by eight labial papillae and a single pair of amphids. Cephalic extremity formed by circumoral annule measuring 7.29 - 9.72 µm in length and 29.16 - 36.45 µm wide and short

second annule. Annulation prominent upto oesophageal region. Buccal cavity simple, 9.72 - 13.36 µm long, 14.58 µm wide. Oesophageal corpus long and cylindrical measuring 0.329 - 0.383 mm in length and 0.024 - 0.036 mm wide. Isthmus short, distinct, 0.017 - 0.029 mm long, 0.021 - 0.029 mm wide. End bulb spherical, 0.077 - 0.092 mm long, 0.075 - 0.099 mm wide with distinct cardia. Nerve ring encircles the oesophagus at 0.145 - 0.196 mm from anterior end. Excretory pore posterior to base of oesophagus, 0.667 - 0.834 mm from anterior end. Vulva posterior to middle of body, 1.531 - 2.581 mm from anterior end. Vagina muscular and anteriorly directed. Eggs with a bunch of polar filaments from each pole, laid in capsules, each capsule usually containing two eggs. Egg shell provided with spine-like outgrowths. Tail short, blunt with spine-like ending.

Male: Body curved ventrally upon fixation. Cuticle annulated. Mouth surrounded by eight labial papillae and a pair of amphids. Buccal cavity small, 4.71 µm long, 4.17 µm wide. Oesophageal corpus cylindrical tapering at both ends, 0.068 - 0.077 mm long, 0.013 - 0.014 mm wide. Testis single reflexed at tip, 0.1450 - 0.328 mm behind the end bulb. Nerve ring surrounding the corpus at 0.048 - 0.053 mm from the anterior end. Excretory pore situated at 0.382 - 0.456 mm from anterior end. Caudal papillae 10 pairs in which 6 pairs pre-anal, 3 pairs post anal, 2 pairs adanal with single median papilla at the base of the caudal appendage. Spicule single. Caudal extremity conical.

Host : *Gryllotalpa africana*

Habitat : Intestine

Locality : Imphal, Manipur (North East India)

Remarks : The present specimen conform well with the measurements and diagrams given by earlier workers except in having slightly smaller egg and in having longer spicules (Eggs = 60 - 66 x 36 - 42 μm, spicule = 26 μm).

Binema anulinervus n. sp.

(Fig. 11)

Dimensions

Holotype female

a = 15.94; b = 6.96; c = 11.76; V = 57.49; L = 2.423 mm; W = 0.158 mm; head annule = 12.15 x 31.59 μm; buccal cavity = 7.29 x 3.36 μm; corpus = 0.254 x 0.036 mm; isthmus = 0.021 x 0.026 mm; end bulb = 0.065 x 0.075 mm; oesophagus = 0.348 mm; excretory pore = 0.520 mm from head end; nerve ring = 0.147 mm from head end; vulva = 1.393 mm from head end; eggs = 60 - 75 x 31.59 μm; tail = 0.217 mm.

Paratype females (n = 20)

a = 12.04 -16.65 (14.25 ± 1.288) ; b = 6.96 - 9.54 (8.217 ± 0.814); c = 11.76 - 15.88 (14.196 ± 1.324); V = 56.16 - 60.21 (57.78 ± 0.990); L = 2.424 - 3.273 (2.896 ± 0.296) mm; W = 0.149 - 0.265 (0.206 ± 0.0361).mm; head annule = 7.29 - 12.15 x 29.16 - 31.59 (9.841 ± 1.175 x 30.739 ± 1.122) μm; buccal cavity = 7.29 x 13.36 – 14.58 μm; corpus = 0.232 - 0.276 x 0.032 - 0.038 (0.256 ± 0.010 x 0.0346 ± 0.001) mm; isthmus = 0.019 - 0.024 x 0.024 - 0.029 (0.020 ± 0.001 x 0.0259 ± 0.001) mm; end bulb = 0.065 - 0.075 x 0.072 - 0.085 (0.071 ± 0.002 x 0.0784 ± 0.003) mm; oesophagus = 0.333 - 0.373 (0.352 ± 0.009) mm; excretory pore = 0.481 -0.623 (0.563 ± 0.041) mm; nerve ring = 0.137 - 0.157 (0.146

± 0.004) mm ; vulva = 1.413 - 1.895 (1.672 ± 0.160) mm ; eggs = 55.89 - 65.61 x 31.59 - 36.45 (61.84 ± 2.044 x 33.89 ± 1.240) µm; tail = 0.176 - 0.216 (0.204 ± 0.009) mm

Paratype males (n = 4)

a = 7.15 - 10 (8.457 ± 1.251); b = 4.23 - 5.16 (4.66 ± 0.442); c = 4.65 - 6.25 (5.312 ± 0.684); L = 1.080 - 1.412 (1.202 ± 0.146); W = 0.108 - 0.181 (0.14 ± 50.033)

Description

Female: The nematodes are small in size, 2.423 - 3.273 mm long, 0.149 - 0.265 mm wide. Mouth surrounded by 8 labiopapillae and a pair of amphids. Lateral alae present throughout the length. Head distinctly set off from the body head annules measure 7.29 - 12.15 µm in length and 29.16 - 31.59 µm in width. Few annulation in cervical region. Buccal cavity distinct, measuring 7.29 µm in length and 13.36 - 14.58 µm in width. Oesophagus 0.333 - 0.373 mm long. Corpus cylindrical measuring 0.232 - 0.276 mm in length, 0.031 - 0.038 mm in width. Isthmus short measuring 0.019 - 0.021 mm in length and 0.024 - 0.029 mm wide having a ring-like ganglion at its middle. End bulb spherical measuring 0.065 - 0.075 mm in length and 0.072 - 0.085 mm in width. Excretory pore lies at 0.481 - 0.623 mm from anterior end, posterior to base of oesophagus. Nerve ring lies almost in the middle of corpus at 0.137 - 0.157 mm from head end. Vulva opens at

1.393 - 1.895 mm from head end which is posterior to middle of body. Vagina directed anteriorly, ovaries two, one anterior and other posterior both reflexed at ends. Eggs oval, 55.89 - 65.61 μm long, 31.59 -34.02 μm wide, covered by filaments, non-encapsulated and laid in pairs. Tail has a flagellate caudal appendage having length of 0.176 - 0.216 mm.

Male: Body small, almost straight upon fixation. Annulation prominent in anterior region. Lateral alae distinct throughout the length. Oral opening surrounded by 8 labial papillae and a pair of amphids. Buccal cavity small measuring 29.16 - 38.88 μm in length and 13.36 - 14.58 μm in width, expanded at its base. Oesophagus 0.23 - 0.288 mm in length. Corpus cylindrical, tapering at both ends measuring 0.170 - 0.216 mm in length and 0.020 - 0.024 mm in width; isthmus a constriction between corpus and bulb measuring 0.046 - 0.017 mm in length and 0.013 - 0.014 mm in width; endbulb measures 0.046 - 0.058 mm long and 0.044 - 0.048 mm wide. Nerve ring lies at 0.176 - 0.204 mm from head end, at posterior-third of the corpus. Excretory pore opens at 0.255 - 0.392 mm from head end. Testes single, reflexed at the tip behind the end bulb which is 0.053 - 0.126 mm away. Caudal papillae four pairs, out of which three pairs are pre-anal and one pair post-anal. Spicule not present. Tail filiform measuring 0.211 - 0.255 mm.

Type host : *Gryllotalpa africana*

Habitat : Intestine

Locality : Imphal, Manipur (North East India)

Type material: Holotype female on slide *Binema anulinervus* n.sp./4, paratype females on slides *Binema anulinervus* n.sp./1-3,5-21; paratype males on slides *Binema anulinervus* n.sp./22-25 deposited in the nematode collection of the Department of Zoology, Aligarh Muslim University, Aligarh, U.P., India.

Diagnosis and relationships

The new species is characterized by female body length 2.423 - 3.273 (2.873) mm, short isthmus with a ring-like sub-ganglion at its middle, non encapsulated eggs, four pairs of caudal papillae and in the absence of spicules in males. *B. anulinervus* n.sp. closely resemble *B. pseudornatum* Leibersperger 1960 in the shape of female tail (i.e., flagellate tail) and buccal cavity , but it differs from *B. anulinervus* in having body measurements (L = 6.98 mm. W = 0.49 mm, oesophagus = 0.56 mm, excretory pore = 1.19 mm; tail = 0.38 mm, vulva = 3.35 mm, egg = 65 - 68 x 38 μm and nerve ring = 3.35 mm and in *B. pseudornatum*), presence of a sub-ganglion at the middle of isthmus, presence of lateral alae in both sexes and in absence of spicule in male.

Key to species of *Binema*

1. Female tail with flagellate caudal appendage.....2

\- Female tail without flagellate caudal appendage.....3

2(1). Female length = 2.423 - 3.273 mm, presence of a subganglion at the middle of isthmus..... *anulinervus* n.sp.

- Female length = 6.98 mm, absence of a subganglion at the middle of the isthmus ..... *pseudornatum* Leibersperger,1960

3(1). Buccal cavity present.....4

- Buccal cavity absent..... *korsakowi* (Sergiev,1923)Basir,1956

4(3). Lateral alae in male present.....5

- Lateral alae in male absent.....6

5(4). Annulation prominent only in cervical region and on female tail = 0.068 - 0.088 mm..... *mirzaia* (Basir,1942)Basir,1956

- Annulation absent in cervical region and on female tail = 0.2-0.21 mm..... ..... *parva* Parveen & Jairajpuri,1985

6(4). Male with 5 pairs of caudal papillae, buccal cavity with ornamention.....7

- Male with 8 pairs of caudal papillae, buccal without ornamention..... .....*striatum* Rizvi &Jairajpuri,2000

7(6). Buccal cavity with 3 sclerotized arches and male tail conical..... *bonaerensis* Camino &Reboredo,1999

- Buccal cavity with projection; male tail forms a caudal spike..... *ornata* Travassos,1925

TABLE-8
Comparative measurement chart of the species of genus *Binema*

Characters	*B.ornata* (mm*)	*B.pseudornatum* (mm*)	*B.korsakowi* (mm*)	*B.mirzaia* (mm*)	*B.parva* (mm*)	*B.striatum* (mm*)	*B.bonaerensis* (mm*)	*B.anu* (m
Female								
Length	2.208-3.562	6.98	1.539-1.796	2.178-3.689	1.54-1.77	1.9-2.95	1.580-1.980	2.424-
Width	0.147-0.284	0.49	0.147-0.206	0.142-0.304	0.14-0.15	0.22-0.32	0.173-0.251	0.149-
Oesophagus	0.294-0.368	0.56	0.309-0.373	0.432-0.5	0.32-0.36	0.34-0.40	0.333-0.364	0.333-
Buccal cavity	4.86-7.29 x 14.48µm	-	-	9.72-13.36 x 14.58µm	15-20 x 14-18µm	12-15mm	-	7.29-1 14.58µ
Excretory pore	0.461-0.579	1.19	0.392-0.422	0.667-0.834	0.41-0.48	0.5-0.670	0.4113-0.423	0.481-
Nerve ring	0.137-0.157	0.225	0.127-0.137	0.145-0.196	0.108-0.122	0.130-0.170	-	0.137-
Vulva	1.374-2.061	3.35	0.971-1.178	1.531-2.581	0.9-1.04	-	-	1.413-
%Vulva	55.15-62.22	47.99	61.56-65.59	69.05-71.06	59	57.6-68.1	64	56.16-
Lateral alae	present	absent	absent	present	present	present	-	presen
Egg	51.03-60.75 x 26.73-29.16µm	65-68µm	51.03-53.46 x 29.16µm	43.74-59.53 x 26.73-31.59µm	55-61x 28-29µm	51-56 x 28-35µm	63.5-105.8 x 30.6-42.3µm	55.89- 31.59-
Tail	0.088-0.108	0.38	0.157-0.166	0.068-0.088	0.2-0.21	0.176-0.320	0.0682-0.0752	0.176-
Male								
Length	0.722-0.966	-	0.710-0.807	0.508-0.818	0.6-0.73	0.84	0.680-0.810	1.080-
Width	0.060-0.098	-	0.077-0.085	0.058-0.092	0.054-0.063	0.075	0.077-0.0821	0.108-
Oesophagus	0.145-0.184	-	0.153-0.160	0.111-0.133	0.11-0.14	0.127	0.125-0.142	0.23-0
Nerve ring	-	-	-	0.048-0.053	0.040-0.050	0.070	-	0.176-
Exc. pore	0.259-0.353	-	0.235-0.262	0.382-0.456	0.2-0.3	-	0.182-0.194	0.255-
Tail	0.029-0.065	-	0.058-0.102	0.021-0.036	0.05-0.07	0.034	0.0407-0.0425	0.211-
Lateral alae	absent	-	present	present	present	present	-	presen
Spicule	34.02-46.17µm	-	36.45-41.31µm	29.16-38.88µm	36µm	36µm	29.5-32.2µm	Absen
Caudal Papillae	6pairs	-	9pairs + 1median papilla	10pairs	9pairs	8pairs	5pairs	4pairs

*All measurements from original descriptions

Genus *Mirzaiella* Basir, 1942a

Basir (1942a) described the genus *Mirzaiella* and placed it in the family Thelastomatidae. Later, he (1956) transferred the genus to the family Oxyuridae based on the presence of 4 cephalic papillae. The type species *Mirzaiella asiatica* Basir, 1942 was reported by Rao (1958) from South India. Singh and Singh (1955) described *M. gryllotalpae* and *M. indicus* under the genus *Gryllocola*, these species were transferred to *Mirzaiella* by Adamson and Waerebeke (1992b) along with the transfer of the genus *Mirzaiella* to the family Travassosinematidae Rao,1958. Farooqui (1967,1968a) reported *M. alii* and *M. haroldi* respectively from Aurangabad, South India. Jarry (1964) from France and Kakulia (1968) from USSR also reported this species.

At present the genus contains five species all described from India.

Generic diagnosis

Cephalic extremity formed by prominent cephalic annule. Oral opening surrounded by 3 lips, one dorsal and two subventral. Buccal cavity long, tubular, formed by 2 distinct parts of almost equal length. Oesophageal corpus very long, widest at its anterior end, shaped like an inverted club, isthmus short and bulb spherical. Excretory pore anterior to the base of the oesophagus. Vulva near posterior-third of body. Vagina short, muscular and anteriorly directed. Amphidelphic. Eggs oval shaped, attached to one another by polar filaments, laid

in mucus capsules, each capsule containing 2-5 eggs. Tail short, blunt or rounded, with or without spine-like appendage. Lateral alae absent in female. Gonads two, ovaries reflexed at both ends, the anterior one extends upto the middle of the corpus and the posterior one a little above the anus. Caudal extremity in male rounded. Caudal papillae 4-7 pairs. Spicule absent. Pointed cuticularized accessory piece present immediately behind the anus.

Mirzaiella asiatica Basir, 1942a

(Fig. 12)

Dimensions

Females (n = 10)

a = 8.03 - 12.42 (9.64 ± 1.157); b = 3.55 - 4.28 (4.049 ± 0.3055) ; c = 9.10 - 14.06 (10.854 ± 1.657); V = 58.78 - 64.84 (62.19 ± 1.839); L = 2.187 - 2.904 (2.53 ± 0.220) mm; W = 0.176 - 0.314 (0.268 ± 0.042) mm; eggs = 60.75 - 65.61 x 31.59 - 34.02 (61.72 ± 1.699 x 32.926 ± 1.206) µm; tail = 0.196 - 0.294 (0.239 ± 0.035) mm.

Males (n = 8)

a = 10.51 - 13 (11.48 ± 0.749); b = 4.251 - 5.33 (4.797 ± 0.373); L = 1.216 - 1.641 (1.393 ± 0.137) mm; W = 0.108 - 0.138 (0.121 ± 0.009) mm; buccal cavity = 29.16 - 36.45 (31.108 ± 3.165) µm; oesophagus = 0.261 - 0.31 (0.290 ± 0.014) mm.

Description

Female: Worms small, slender and straight upon fixation. Cuticle annulated, more pronounced in anterior region. Head annule distinct, 26.73 - 36.45 µm long, 31.59 - 38.88 µm wide. Mouth opening small and subtriangular surrounded by 3 well developed lips, one dorsal and two subventral. Lateral alae absent. Buccal cavity 53.46 - 63.18 µm long, divided into two portions of almost equal length, the

anterior part being 24.3 - 31.59 µm wide, posterior part 26.73 - 31.59 µm wide. Oesophagus 0.566 - 0.686 mm long. Corpus cylindrical, 0.462 - 0.570 mm long, the anterior portion broader, 0.034 - 0.038 mm wide and the posterior portion narrower 0.024 - 0.026 mm wide. Isthmus distinct, 0.017 - 0.019 mm long, 0.019 - 0.024 mm wide. End bulb spherical, 0.087 - 0.099 mm long, 0.087 - 0.102 mm wide, cardia distinct. Nerve ring located at 0.255 - 0.294 mm from anterior end. Excretory pore anterior to base of oesophagus, 0.549 - 0.667 mm from anterior end. Vulva opens at 1.393 - 1.736 mm from head end. Gonads amphidelphic, ovaries two, one anterior extending upto the middle of the corpus and the posterior one upto anal opening, both reflexed at ends. Eggs oval, have polar filaments at each pole, enclosed in a capsule containing 2-3 eggs.

Male: Worms small, curved ventrally upon fixation. Cuticle annulated throughout the whole length of body. Lateral alae starts a little above the nerve ring and extends upto posterior end. Head annule distinct, 12.15 - 15.79 µm long, 24.3 - 26.73 µm wide. Corpus 0.194 - 0.233 mm long, 0.024 -0.026 mm wide; isthmus short, 0.012 - 0.019 mm long, 0.014 - 0.017 mm wide; end bulb 0.055 - 0.060 mm long, 0.051 - 0.057 mm wide. Nerve ring encircles the corpus at 0.170 - 0.206 mm from head end. Excretory pore post-oesophageal, 0.363 - 0.491 mm from head end. Testes single, reflexed at tip. Caudal extremity truncated bearing distinct

caudal alae. Caudal papillae 5 pairs; one pair large ventral and preanal; one pair subventral preanal; one pair small ventral preanal; one pair adanal double papillae and one pair lateral postanal papillae near posterior end of tail. Spicule absent. Pointed cuticularised accessory piece rod-like having a length of 21.87 - 34.02 μm, present immediately behind the anus.

Host : *Gryllotalpa africana*

Habitat : Intestine

Locality : Imphal, Manipur (North East India)

Remarks : The present specimens conform well with the measurements and description of *M. asiatica* given by earlier workers except in having longer male, slightly longer oesophagus and slightly larger egg (Male = 0.07 – 1.08 mm, oesophagus = 0.261 - 0.31 mm; egg = 66 - 70 μm x 42 - 45 μm).

Key to species of *Mirzaiella*

1. Female tail with a distinct constriction in the middle.....*alii* Farooqui,1967

\- Female tail without any constriction.....2

2(1). Caudal papillae 4 pairs.....3

\- Caudal papillae more than 4 pairs.....4

3(2). Female oesophagus 0.58 - 0.657 mm long and vulva about 63 - 67% of body length...*indicus* (Singh & Singh,1955) Adamson & Waerebeke,1992b

\- Female oesophagus 0.119 - 0.124 mm long and vulva about 58-62% of body length.....

..... *gryllotalpae*(Singh & Singh,1955)Adamson & Waerebeke,1992b

4(2). Caudal papillae 5 pairs .....*asiatica* Basir,1942

- Caudal papillae 7 pairs.....*haroldi* Farooqui,1968.

TABLE- 9

Comparative measurement chart of the species of genus *Mirzaiella*

Characters	*M. alii* (mm*)	*M. haroldi* (mm*)	*M. indicus* (mm*)	*M. gryllotalpae* (mm*)	*M. asiatica* (mm)
Female					
Length	2.53-4.30	2.18-3.1	1.948-2.328	1.948-2.185	2.187-2.904
Width	0.37-0.38	0.27-0.42	0.226-0.248	0.228-0.238	0.176-0.314
Oesophagus	0.54-0.76	0.66-0.78	0.58-0.657	-	0.566-0.686
Nerve ring	0.24-0.29	0.32-0.69	0.236-0.295	0.161	0.255-0.294
Excretory pore	0.4-0.5	0.50-0.69	0.496-0.558	0.434-0.496	0.549-0.667
Vulva	0.94-1.04	1.37-1.88	1.311-1.473	1.131-1.364	1.393-1.736
Egg	61-70 x 32-37µm	66-68 x 41-43µm	56-62 x 34µm	53-56 x 30-31µm	60.75-65.61 x 31.59-34.02µm
Male					
Length	1.04-1.6	1.45	-	1.071-1.397	1.216-1.641
Width	0.13-0.18	0.13	-	0.093-0.112	0.108-0.138
Oesophagus	0.24-0.29	0.412	-	0.301-0.31	0.261-0.31
Nerve ring	0.15-0.18	0.23	-	0.190-0.202	0.170-0.206
Excretory pore	0.5-0.6	-	-	0.357-0.434	0.363-0.491
Caudal papillae	6 pairs	7 pairs	-	4 pairs	5 pairs
Spicule	absent	absent	-	25µm	absent

*All measurements from original descriptions

CHAPTER – III

Family **Pseudonymidae** Kloss, 1958

Kloss (1960), Skrjabin *et al.*,(1966) and Poinar (1977) divided thelastomatid genera in 20 subfamilies under 7 families based on primitive characters. Adamson (1989) recognised only five families under the superfamily Thelastomatoidea namely Hystrignathidae Travassos, 1920; Pseudonymidae Kloss, 1958; Protrelloididae Chitwood, 1932; Chitwoodellidae Kloss, 1960 and Thelastomatidae Travassos, 1929. Adamson and Waerebeke (1992b) synonymised the family Chitwoodellidae with Travassosinematidae. The family Gyoeryiinae Kloss,1958 was also synonymised with the family Pseudonymidae proposed by him earlier (1989) and included 5 genera under the family viz., *Itaguaiana* Kloss 1959; *Pseudonymus* Diesing, 1857; *Jarryella* van Waerebeke & Remillet,1973; *Stegonema* Travassos, 1954 and *Zonothrix* Todd,1942. The family Pseudonymidae essentially consists of parasites of water scavenger beetles of the family Hydrophilidae except the genus *Jarryella* which parasitizes terrestrial beetles of the family Scarabaeidae.

Diagnosis

The family Pseudonymidae is diagnosed by the presence of filaments coiled around egg shell and in the absence of polar egg filaments.

Key to the genera of Pseudonymidae

1. Cephalic extremity formed by circumoral annule and expanded second annule in female.....2

- Cephalic extremity formed by circumoral annule and simple second annule in female.....3

2(1). Anterior cuticle in female with transverse rows of scales.....*Stegonema* Travassos, 1954

- Anterior cuticle in female without transverse rows of scales.....*Pseudonymus* Diesing, 1857

3(1). Eggs broadly oval with filaments coiled around shell.....4

- Eggs elongate with filaments.....*Itaguaiana* Kloss, 1959a

4(3). Vulva with protruding anterior lip near posterior-third of body; male tail conical with 7 pairs of caudal papillae .....*Zonothrix* Todd, 1942

- Vulva slightly posterior to midbody; male tail subconical with 5 pairs of caudal papillae.....*Jarryella* van Waerebeke & Remillet, 1973

Genus *Pseudonymus* Diesing, 1857

Synonyms

Ptychocephalus Diesing, 1861
Oxyuris (Helicothrix) Galeb, 1878a
Galebiella Basir, 1941
Toddia Travassos, 1954
Toddinema Travassos in Theodorides, 1957
Gyoeryia Kloss, 1958

The genus *Pseudomymus* was erected by Diesing (1857) to accommodate *Oxyuris spirotheca* as its type species which had been described by Gyory in 1856 from aquatic beetles, *Hydrophilus piceus.* Galeb (1878) described and figured 4 species of nematodes from hydrophilid beetles, among which was *Oxyuris (Helicothrix) spirotheca* from the beetles, *Hydrophilus piceus*, erected the subgenus *Helicothrix* to accommodate the four worms. Stiles and Hassal (1905) indicated *Helicothrix* to be a synonym of *Pseudonymus* and designated *P. spirotheca* as type of the genus which was followed by subsequent workers. Basir(1941) established the genus *Galebiella* for two worms, *G. galebiella* and *G. islamabadi* from aquatic beetles in India. He distinguished *Galebiella* from the genus *Leidynemella* Chitwood (1934) but did not comment about the genus *Pseudonymus* at that time. However, the genus *Galebiella* agrees with the genus *Pseudonymus* noticeably in the fact that both possess enlarged cephalic annules as also in other morphological characters. Both the genera are parasitic in beetles. Skrjabin, Schikhobalova and Mosgovoy (1951) included 4 species under the genus *Pseudonymus* Diesing, 1857 viz., *P. spirotheca* (Gyory, 1856) Diesing, 1857;

P. brachycercus Todd,1944; *P. hydrophili* (Galeb, 1878) and *P. leptocercus* (Todd,1944). Basir (1956) in his monograph on oxyuroid parasites of Arthropoda, placed *Galebiella* Basir, 1941, *P. brachycercus* Todd, 1944 and *P. leptocercus* as synonyms of *P. hydrophili* and *Zonothrix tropisterna* Todd,1942 as synonyms of *P. hydroi*. However, he was against the establishment of a separate genus *Zonothrix* which is closely related to the genus *Pseudonymus* and is distinguished by the presence or absence of inflated head annule. Basir (1956) synonymised the genus *Galebiella* with *Pseudonymus* and redescribed *P. islamabadi* as a new combination. Rao (1958) reported *P. hydrophili* from India. Fotedar (1964) described *P. multiannulata* from an aquatic beetle from Kashmir. Farooqui (1967) described *P. klossi* and *P. mehdii* from aquatic beetle *Dytiscus marginicollis* from Maharastra, the latter species was synonymised with *Zonothrix mehdii* by Adamson and Waerebeke (1992b). Gupta and Kaur (1978) described *P. reuhmi* from India. Travassos (1954) described *P. vazi* and *Toddinema toddi*, the latter species was synonymised with *P. toddi* by Kloss (1959 e,f,g). Adamson and Waerebeke (1992b) while revising the superfamily Thelastomatoidea considered *Pseudonymus* as a distinct genus and listed all the known species reported from all over the world.

At present the total number of species under the genus is 10 of which 4 species are reported from India excluding the new species.

Diagnosis (emended)

Female: Cephalic extremity formed by circumoral annule and expanded second annule. Oesophageal corpus clavate. Isthmus a constriction between corpus and bulb. Vulva near posterior-third of the body. Vagina short, anteriorly directed. Gonads amphidelphic. Eggs broadly oval with filaments twisted around shell, polar egg filaments absent. Tail filiform or bluntly attenuated or conically attenuated or conical.

Male: Cephalic extremity formed single annule. Corpus cylindrical. Caudal papillae 3-6 pairs. Spicule present or absent. Caudal appendage consists of 1 or 2 parts.

Pseudonymus basiri n. sp.

(Fig. 13)

Dimensions

Holotype female

a = 13.05; b = 7.02 ; c = 8.29, V= 61.32, L = 2.689 mm; W = 0.206 mm, head = 12.12 x 34.02µm ; buccal cavity = 9.72 x 7.29 µm; corpus = 0.294; isthmus = 0.012 x 0.021 mm; end bulb = 0.077 x 0.082, 1st annule = 29.16 x 70.47 µm, oesophagus = 0.383 mm, excretory pore = 0.471 mm, nerve ring = 0.225 mm; egg = 75.33 x 41.31 µm; tail = 0.324; vulva = 1.649 mm.

Paratype females (n = 9)

a = 11.81 - 16.21 (13.951 ± 1.396); b = 5.169 - 8.86 (7.406 ± 1.332); c = 6.88 - 12.47 (9.723 ± 1.784); V = 50.92 - 62.89 (60.89 ± 3.789) ; L = 1.618 -3.372 (2.658 - 0.636) mm; W = 0.137 - 0.245 (0.189 ± 0.037) mm ; head = 9.72 - 12.15 x 31.59 -38.88 (11.88 ± 1.460 x 36.18 ± 2.835) µm; 1st annule = 19.44 - 29.16 x 60.75 - 75.33 (26.46 ± 3.315 x 66.69 ± 5.025) µm; buccal cavity = 7.29 - 9.72 x 7.29 (8.64 ± 1.280 x 7.29) µm; corpus = 0.235 - 0.304 (0.271 ± 0.023) mm; isthmus = 0.012 - 0.017 x 0.019 - 0.024 (0.0136 ± 0.001 x 0.022 ± 0.002) mm; end bulb = 0.058 - 0.077 x 0.065 - 0.087 (0.0686 ± 0.006 x 0.0786 ± 0.007) mm; pseudobulb = 0.053 - 0.072 x 0.046 - 0.063 (0.0633 ± 0.007 x 0.055 ± 0.006) mm oesophagus = 0.309 - 0.386 (0.355 ± 0.0292) mm; excretory pore =

0.373 - 0.549(0.478 ± 0.0685) mm from anterior end ; nerve ring = 0.176 - 0.225 (0.215 ± 0.020) mm from anterior end ; vulva = 0.824 - 2.106 (1.632 ± 0.439) mm; eggs = 70.47 - 77.76 x 41.31 - 43.74 (73.44 ± 2.361 x 41.984 ± 1.071) μm; tail = 0.216 - 0.304 (0.271 ± 0.030) mm.

Paratype males (n = 5)

a = 12.06 - 19.25 (15.93 ± 2.817); b = 3.98 - 5.65 (5.17 ± 0.678); c = 40 -63.11 (51.21 ± 9.985)

Description

Female : The female measures 1.618 - 3.372 mm in length and 0.137 - 0.245 mm in maximum width. The mouth is surrounded by 8 submedian labiopapillae and a pair of amphids. The head end is set off and measures 9.72 - 14.58 μm in length, 31.59 - 38.88 μm in width. The subsequent annules are very much reduced in size and are faint, mainly restricted to anterior portion. Buccal cavity very short, cylindrical, 7.29 - 9.72 μm long, 7.29 μm wide. The nerve ring is located at 0.176 -0.245 mm from anterior end. Excretory pore opens behind base of oesophagus at 0.373 - 0.549 mm from anterior end. Oesophagus 0.313 - 0.386 mm long consisting of a cylindrical corpus measuring 0.235 - 0.304 mm long; a pseudobulb 0.053 - 0.072 mm long, 0.046 - 0.063 mm wide; a short isthmus, 0.012 - 0.017 mm long, 0.019 - 0.026 mm wide and a posterior valvular endbulb, 0.058 - 0.077 mm long, 0.065 - 0.087 mm wide. Vulva 0.824 - 2.1.06 mm from anterior

end. Eggs oval in shape, 70.47 - 77.76 μm long, 41.31 - 43.74 μm wide, ensheathed in a spiral filament and containing fully formed embryo when deposited. Tail conical, 0.216 - 0.324 mm long.

Male: The male 0.760 - 1.261 mm in length and 0.059 - 0.083 mm in the maximum body diameter. The head annule measures 4.71 - 5.65 μm in length and 12.18 - 14.58 μm in width. Buccal cavity very short, 3.76 -4.86 μm long and 2.355 μm – 3.76 μm wide. Oesophagus 0.191 - 0.223 mm long, consisting of a corpus which narrows down towards anterior end measuring 0.143 - 0.173 mm in length and 0.017 - 0.018 mm in maximum width; an isthmus, 0.009 - 0.014 mm long, 0.012 - 0.013 mm wide; and pyriform valvular end bulb, 0.034 - 0.041 mm long, 0.031 - 0.041 mm wide. Pseudobulb absent. The nerve ring encircles the corpus at 0.126 - 0.145 mm from anterior end. Excretory pore opens far behind the base of oesophageal bulb at 0.206 - 0.30 mm from anterior end. A single spicule measuring 25.55 - 28.26 μm present. Caudal papillae consists of 6 pairs of which 2 pairs are preanal (one pair subventral , one pair lateroventral), one pair lateral adanal and three pairs postanal papillae (one small pair ventrally a little behind the anus, one subventral pair and a pair at caudal appendage). Tail measuring 0.018 - 0.024 mm in length.

Type host : *Hydrophilus triangularis*

Habitat : Anterior gut

Locality : Imphal, Manipur (North East India)

Type material : Holotype female on slide *Pseudonymus basiri* n.sp./1, paratype females on slides *Pseudonymus basiri* n.sp./2-9; paratype males on slides *Pseudonymus basiri* n.sp./1-5 deposited in the nematode collection of the Department of Zoology, Aligarh Muslim University, Aligarh-202002(UP), India. The species is designated *Pseudonymus basiri* n.sp in honour of (late) Prof. M. A. Basir.

Diagnosis and relationships

Pseudonymus basiri n.sp. is characterised by presence of 6 pairs of caudal papillae in males, presence of a spicule having a length of 25.55-28.26μm; absence of cuticular annulations and pseudobulb in male; presence of conical tail, vulval lip and pseudobulb in female.

Among the known species *Pseudonymus basiri* n.sp. resembles *P. brachycercus* Todd,1944; *P. hydrophili* Galeb,1878 and *P. leptocercus* Todd,1944 in having two cephalic cuticular annules. However, it differs from *P. leptocercus* in presence of conical tail as opposed to filiform tail in the latter. It also differs from *P. brachycercus* in having shorter female body, shorter oesophagus, position of excretory pore, nerve ring, vulva and in having smaller eggs (L = 3.15-4.11 mm, oesophagus = 0.43 - 0.50 mm, excretory pore = 0.52 –

0.65 mm, nerve ring = 0.233 - 0.295 mm, vulva = 1.772 - 2.616 mm and egg = 78 - 88 x 48 – 55 μm in *P. brachycercus*). From *P. hydrophili* it differs in having 6 pairs of caudal papillae in male as against 3 pairs of caudal papillae in *P. hydrophili.*

Key to species of *Pseudonymus*

1. Cephalic cuticular annule = 2.....2

- Cephalic cuticular annule more than 2.....5

2(1). Female tail conical.....3

- Female tail filiform.....*leptocercus* Todd,1944

3(2). Eggs = 78 - 88 μm in length.....*brachycercus* Todd, 1944

- Eggs less that 78 – 88 mm in length.....4

4(3). Caudal papillae 3 pairs.....*hydrophili* (Galeb,1878) Basir, 1956

- Caudal papillae 6 pairs.....*basiri* n.sp.

5(1). Cephalic cuticular annule = 6 .....*klossi* Farooqui, 1967

- Cephalic cuticular annule more than 6.....6

6(5). Female tail filiform.....7

- Female tail conical.....8

7(6). Cephalic cuticular annule = 9.....*spirotheca*(Gyory,1856) Diesing,1857

- Cephalic cuticular annule = 30.....*multiannulata* Fotedar,1964

8(6). Cephalic cuticular annule less than 60.....9

- Cephalic cuticular annule more than 60.....*reuhmi* Gupta & Kaur, 1978

9(8). Oesophagus = 0.450 mm in length .....*islamabadi* (Basir, 1941) Basir,1956

- Oesophagus less than 0.450 in length.....10

10(9). Caudal papillae = 3 pairs.....*vazi* Travassos, 1954

- Caudal papillae = 5 pairs.....*toddi* (Travassos, 1954) Kloss, 1959

TABLE-10
Comparative measurement chart of the species of genus *Pseudonymus*

Characters ▼	*P.spirotheca* (mm*)	*P.brachycercus* (mm*)	*P.hydrophili* (mm*)	*P.islamabadi* (mm*)	*P.klossi* (mm*)	*P.leptocercus* (mm*)	*P.multiannulata* (mm*)	*P.reuhmi* (mm*)	*P.toddi* (mm*)	*P.vazi* (mm*)	*P.basiri* n.sp. (mm)
Female											
Length	1-2.66	3.15-4.11	1.85-4.11	4.3	2.41-2.51	2.47-2.94	2.0-3.2	3.3-3.5	1.7-3.1	2.0-2.6	1.618-3.372
Width	-	0.218-0.295	0.145-0.295	0.375	0.23-0.26	0.145-0.22	0.23-0.4	-	0.15-0.29	0.15-0.20	0.137-0.245
Oesoph.	-	0.43-0.50	0.265-0.385	0.450	0.30-0.42	0.385-0.423	0.37-0.43	0.480-0.5	0.29-0.40	0.39-0.45	0.313-0.386
Exc.pore	-	0.52-0.65	0.39-0.65	0.6	0.52-0.61	0.484-0.546	0.55	-	0.44-0.55	0.43-0.525	0.373-0.549
N.ring	-	0.233-0.295	0.2-0.295	0.270	0.25-0.28	0.2-0.25	0.31	-	0.20-0.26	0.25-0.322	0.176-0.245
Vulva	Mid body	1.772-2.616	1.170-2.616	2.6	1.41-1.45	-	1.35	-	1.05-1.53	1.0-1.241	0.824-2.106
Egg	Ellipsoidal	78-88 x 48-55µm (oval)	68-82 x 42-52µm (oval)	Oval	75-83 x 52-54µm (oval)	78-88 x 48-55µm (oval)	60-85 x 45-48µm (oval)	75-85 x 42-45µm (oval)	62-81 x 38-52µm (oval)	67-83x 40-43µm	70.47-77.76 x41.31-43.74 µm (oval)
Tail	-	0.361-0.438	0.255-0.483	0.260	0.29-0.31	0.381-0.463	0.33-0.36	-	0.27-0.40	0.38-0.49	0.216-0.324
Shape	Filiform	Bluntly, attenuated	Conical, attenuated	Conical attenuated	Conical, attenuated	Filiform	Filiform	Conical	Conical	Conical	Conical
CCA	9	2	2	9	6	2	30	>60	23	7	2
Male											
Length	0.7	-	1.0-1.5	-	-	-	-	-	0.75-1.0	1.34-1.38	0.76-1.261
Width	-	-	-	-	-	-	-	-	0.05-0.08	0.09-0.11	0.059-0.083
Oesoph.	-	-	-	-	-	-	-	-	0.18-0.21	0.23	0.191-0.223
Exc.pore	-	-	-	-	-	-	-	-	0.265	0.37-0.38	0.206-0.3
N.ring	-	-	-	-	-	-	-	-	-	-	0.126-0.145
Tail	-	-	-	-	-	-	-	-	0.037	0.06	0.018-0.024
C.papillae	3 pairs	-	3 pairs	-	-	-	-	-	5 pairs	3 pairs	6 pairs
Spicule	-	-	-	-	-	-	-	-	-	32µm	25.55-28.26 µm
C. pap.	2 piece	-	1 piece	-	-	-	-	-	-	-	-

* All measurements from original descriptions

Abbreviations used: Oesoph = Oesophagus, Exc.pore = Excretory pore, N.ring = nerve ring, C.pap. = Caudal papillae, CCA= Cephalic cuticular annule

Genus *Zonothrix* Todd, 1942

Todd (1942) erected the genus *Zonothrix* to accommodate *Zonothrix tropisterna* as its type species collected from hydrophilid beetle *Tropisternus nimbatus* which he distinguished *Zonothrix* from its most closely related genus *Pseudonymus* in lacking inflated cervical annules and by the posterior position of the vulva. In fact some *Zonothrix* spp. do have inflated annules but they are discontinuous and irregular in number and size, those of *Pseudonymus* spp. form a complete ring around the cervical region although they appears to vary in size and number (Jarry, 1964). Galeb (1878b) described and figured four species of nematodes from hydrophilid beetles in Europe which he placed in the genus *Oxyuris*, subgenus *Helicothrix*; with *Oxyuris spirotheca* Gyory, 1856 as type species. Diesing (1857) named the genus *Pseudonymus* for *Oxyuris spirotheca* which became *Pseudonymus spirotheca* (Gyory, 1856) Diesing,1857. Stiles & Hassal (1905) considered *Helicothrix* to be a synonym of *Pseudonymus*. Basir (1956) considered *Zonothrix* a synonym of the genus *Pseudonymus*. Adamson and Waerebeke (1992b) while revising the family Pseudonymidae considered *Zonothrix* a valid genus and included 10 species under the genus from the world over. In present study a new species namely *Z. imphali* has been described.

Diagnosis (emended)

Female: Cephalic extremity formed by circumoral annule and simple second annule. Oesophageal end bulb gently clavate with or without pseudobulb. Isthmus a constriction between corpus and bulb. Cardia may or may not be modified into a branch-like structure posteriorly. Vulva with protruding anterior lip near posterior-third of the body. Vagina short, anteriorly directed. Gonads amphidelphic. Eggs broadly oval with filaments coiled around shell. Tail conical

Male: Cephalic extremity formed by single annule. Corpus cylindrical. Caudal extremity conical. Spicule present. Caudal papillae consisting of one pair pre-anal subventral, one pair adanal sublateral, three pairs circumanal of which one pair preanal and one pair adanal and one pair postanal and two pairs on tail, of which one is sublateral and one subventral.

Zonothrix imphali n. sp.

(Fig. 14)

Dimensions

Holotype female

a = 17.76; b = 9.32; c = 10.05; V = 62.81 ; L = 3.749 mm; W = 0.211 mm; buccal cavity = 9.72 x 7.29 μm; corpus = 0.324 mm long; isthmus = 0.014 x 0.029 mm; end bulb = 0.085 x 0.094 mm; oesophagus = 0.402 mm; excretory pore = 0.618 mm; nerve ring = 0.255 mm; vulva = 2.355 mm; eggs = 77.76 x 43.74 μm; tail = 0.373 mm.

Paratype females (n = 3)

a = 16.3 - 18.99 (17.37 ± 1.426); b = 8.38 - 9.69 (9.106 ± 0.666); c = 10.11-12.28 (11.42 ± 1.1528); V = 61.05 - 64.05 (62.903 ± 1.620); L = 3.277 -4.274 (3.835 ± 0.509) mm; W = 0.201 - 0.235 (0.220 ± 0.0174) mm; head annule = 9.72 - 12.15 x 38.88 (10.53 ± 1.402 x 38.88) μm; buccal cavity = 9.72 x 7.29 - 12.15 (9.72 x 10.123 ± 2.528) μm; corpus = 0.304 - 0.343 (0.320 ± 0.0202) mm; isthmus = 0.019 - 0.024 x 0.024 - 0.029 (0.0206 ± 0.002 x 0.0263 ± 0.002) mm; end bulb = 0.058 - 0.077 x 0.080 - 0.089 (0.0683 ± 0.009 x 0.0853 ± 0.004) mm; oesophagus = 0.391 - 0.441 (0.4196 ± 0.025) mm; excretory pore = 0.608 - 0.746 (0.680 ± 0.0692) mm; nerve ring = 0.265 - 0.284 (0.274 ± 0.009) mm; egg = 72.9 - 77.76 x 41.31 - 43.74 (76.14 ± 2.805 x 42.12 ± 1.402) μm; vulva = 2.099 - 2.719 (2.4106 ± 0.310) mm; tail = 0.324 - 0.348 (0.335 ± 0.0121) mm.

Description

Only female specimens of the species were collected, as males could not be found. Body large, 3.227 - 4.274 mm long, 0.201 - 0.235 mm wide. Head end with single inflated cephalic annule. Head annule 9.72 - 12.15 μm long, 36.45 - 38.88 μm wide . Buccal cavity 9.72 μm long, 7.29 - 10.93 μm wide. A lobe-like structure hangs from the base of the lip region. No cells are observed within the lobe, however, it is pigmented, subepidermal in origin and is presumed to provide some mechanical support while feeding. Mouth opening prismoidal and surrounded by circumoral elevation having eight submedian labial papillae. Amphids present. Oesophagus 0.391 - 0.441 mm long consisting of a cylindrical corpus of 0.304 - 0.343 mm long. Isthmus very short, 0.014 - 0.024 mm long, 0.024 - 0.029 mm wide. End bulb 0.058 - 0.085 mm long, 0.080 - 0.094 mm wide. Nerve ring encircles the posterior portion of the corpus at 0.255 - 0.284 mm from anterior end. Excretory pore a large opening projecting out of the body situated posterior to base of the oesophagus at 0.608 - 0.746 mm from anterior end. Vulva at posterior-third of the body, 2.099 - 2.719 mm from anterior end with protruding lip. Amphidelphic. Eggs oval, 72.9 - 77.76 μm long, 41.31 - 43.74 μm wide with filaments coiled around the shell. Tail conical, 0.324 - 0.373 mm long.

Diagnosis and relationships

Zonothrix imphali n.sp. differs from all the known species of the genus for having prominent cervical alae extending from anterior extremity upto the level of the base of oesophagus, vulva posteriorly situated with protruding anterior lip and presence of a pseudobulb which is absent in all species of the genus *Zonothrix*.

Type host : *Hydrophilus triangularis*

Habitat : Fore gut

Locality : Imphal, Manipur (North East India)

Type material : Holotype female on slide *Zonothrix imphali* n.sp./26, paratype females on slides *Zonothrix imphali* n.sp./27,28,29 deposited in the nematode collection of the Department of Zoology, Aligarh Muslim University, Aligarh, U.P., India. The new species is designated *Zonothrix imphali* after Imphal, the state capital of Manipur (India).

Key to species of *Zonothrix*

1. Body of female C-shaped after fixation 2

- Body of female coiled after fixation..... *izecksohni* Kloss, 1959

2(1). Posterior end of corpus in female narrower than oesophageal bulb.....3

- Posterior end of corpus in female almost as broad as oesophageal bulb..... *hydroi* (Galeb, 1878) Todd, 1942

3(2). Mature female more than 2- 5 mm long.....4

- Mature female less than 2 mm long..... *helocharesae* Kloss, 1959

4(3). Swollen annulation present in cephalic extremity of female.....5

- Swollen annulation absent in cephalic extremity of female..... ..... *tropisterna* Todd, 1942

5(4). Cephalic annule in female not inflated.....6

- Cephalic annule in female inflated..... *imphali* n.sp.

6(5). Female tail narrowing behind anus and not continuing as a spine-like caudal extension.....8

- Female tail not as above.....7

7(6). Caudal extremity of female terminating in a short spine-like structure.....9

- Caudal extremity of female without spine-like appendage.....10

8(6). Female tail conical; Ex. = *Coleostoma luederwaldi* ..... *gladius* Kloss, 1959

- Female tail conically attenuated; Ex.= *Dytiscus marginicollis* .... *mehdii* (Farooqui, 1967) Adamson & Waerebeke,1992

9(7). Caudal spine of female = 26 – 35 μm long..... *galebi* Kloss, 1959

- Caudal spine of female less than 10μm long..... *paraense* Kloss, 1959

10(7). Distance between vulva and anus 20-28% total body length, tail of female 5-8% of body length; 7 pairs of caudal papillae in male..... ..... *columbianus* Adamson & Buck, 1990

- Distance between vulva and anus less than 15% of total body length, tail of female 10% of body length; 6 pairs of caudal papillae in male..... ..... *adversa* Kloss, 1958

CHAPTER – IV

Family **Protrelloididae** Chitwood, 1932

Chitwood (1932) proposed the subfamily Protrelloidinae under the family Thelastomatidae to accommodate worms with anteriorly situated vulva. Basir (1956) did not accept subfamily. Farooqui (1970) supported Chitwood's subfamily and added a genus *Protrellatus* to it. Adamson (1989) elevated this subfamily to the rank of family Protrelloididae different from the family Thelastomatidae. Herein, we also consider the family Protrelloididae as valid under the superfamily Thelastomatoidea.

Diagnosis

Mouth with or without trilobed circumoral elevation. Cuticle without spines. Anterior region may or may not possess transverse striations. Oesophagus consisting of corpus which may be clavate or cylindrical, isthmus distinct or indistinct and a posterior valvular bulb. Vulva anterior to base of the oesophagus. Gonads amphidelphic. Eggs with or without cuticular crest or grooves. Tail of female attenuate to conical terminating in narrow spine or short and subconical or short and rounded with two cuticular wing like projections. Male caudal extremity tapering posterior to anus and ending in digitiform appendage or short and subconical or narrowing, with long appendage or short and bluntly rounded or subconical. Caudal papillae 3-8 pairs or completely absent. Spicule single or absent.

Key to genera of Protrelloididae

1. Cephalic extremity in female formed by lip cone and second annule large..2

- Cephalic extremity in female simple, second annule normal.....

.....*Protrellatus* Farooqui, 1970

2(1). 4 pairs of caudal papillae in male.....3

- 3 pairs of caudal papillae in male.....*Protrellus* Cobb,1920

3(2). Egg with cuticular modifications.....4

- Egg without cuticular modification.....*Protrellata* Chitwood, 1932

4(3). Female tail conically attenuated; male tail digitiform.....

.....*Protrelloides* Chitwood,1932

- Female tail short, male tail not digitiform.....*Napolitana* Kloss,1959a

Genus *Protrellus* Cobb, 1920

Cobb (1920) proposed the genus *Protrellus* for *P. aureus* from an Australian cockroach *Polyzosteria* sp. Schwenk (1926) described *Protrellus galebi* from another unnamed cockroach. Travassos (1929) transferred *Oxyuris kunckeli* Galeb, 1878a and *Oxyuris australasiae* Pessoa & Correa,1926 to *Protrellus.* Chitwood (1932) proposed three genera *Protrelloides, Protrellata* and *Protrellina* in a new subfamily Protrelloidinae of the family Thelastomatidae based on the position of the vulva anterior to the oesophagus. He transferred *P. galebi, P. kunckeli* and *P. australasiae* to the genus *Protrellina* proposed by him and added two new species *P. manni* and *P. aurifluus.* He regarded Cobb's *P. aureus* as a *species inquirenda* and did not recognise *Protrellus* as a valid genus. Later, Chitwood (1933) considered that *Protrellus* and *Protrellina* were identical and reinstated the senior name for the genus *Protrellus.* Basir (1942b) described *Protrellina phyllodromi* but later in 1956 he synonymysed it with genus *Protrellus.* Basir (1956) also invalidated Chitwood's subfamily Protrelloidinae on the grounds that vulva is variable in thelastomatids and is not a well-defined character on which to erect a subfamily. Kloss (1961,1966) and Dale (1966), seemingly ignorant of Chitwood's (1933) paper, described new thelastomatids in the genus *Protrellina* (*P. eurycotesi* Kloss,1961; *P. ischnopterae* Kloss,1966; *P. ituana* Kloss,1966; and *P. gurri* Dale,1966). van Waerebeke (1969), however, used the name *Protrellus* while describing two new species *P. rasolofi* and

P. behorefi. Farooqui (1970) re-established Chitwood's subfamily Protrelloidinae in which he included *Protrelloides* Chitwood,1932, *Protrellata* Chitwood,1932 and *Protrellus* Cobb,1920; and he also assigned a new genus *Protrellatus* to it. Adamson (1989) raised Chitwood's subfamily to the rank of family Protrelloididae. Adamson & Waerebeke (1992b) while revising the family Protrelloididae included 5 genera in the family, namely *Protrellus* Cobb,1920, *Protrelloides* Chitwood,1932, *Protrellata* Chitwood,1932, *Napolitana* Kloss,1959a, *Ptotrellatus* Farooqui,1970. Zervos (1987a,b) reported two species *P. dixoni* and *P. dalei* from New Zealand cockroaches.

At present the genus contains 13 species reported from the world out of which 2 species are described from India.

Diagnosis (emended)

Female: Cephalic extremity formed by lip cone and expanded second annule. Oesophageal corpus clavate. Isthmus short. Vulva anterior to base of oesophagus. Vagina and common uterus posteriorly directed, paired uteri opposed. Eggs elongate, oval or ellipsoidal, shell usually bearing longitudinal ridges or excrescences or a circular crest either laterally or towards one of the poles. Tail short, conical to attenuate.

Male: Corpus cylindrical. Caudal extremity subconical. Spicule present. Testes single. Caudal papillae 3-5 pairs.

Protrellus shamimi n. sp.

(Fig. 15)

Holotype female

a = 21.81; b = 11.36; c = 37.22; V = 5.54; L = 4.057 mm; W = 0.186 mm; head + 1st annule = 19.44 x 38.88 µm; buccal cavity = 9.72 x 17.01 µm; oesophagus = 0.357 mm; excretory pore = 0.191 mm; nerve ring = 0.147 mm ; vulva = 0.225; egg = 75.33 x 41.431µm; tail = 0.109 mm.

Paratype females (n = 10)

a = 19.82 - 26.76 (22.45 ± 2.203); b = 8.57 - 13.88 (11.566 ± 1.545); c = 25.81 - 48.86 (34.981 ± 6.569); V = 4.39 - 7.53 (5.327 ± 0.879); L = 2.865 - 4.917 (4.18 ± 0.644) mm; W = 0.137 - 0.216 (0.186 ± 0.022) mm; head + 1st annule = 17.01 - 21.87 x 31.59 - 41.31 (18.954 ± 1.536 x 37.908 ± 2.852) µm; buccal cavity = 9.72 - 14.58 x 12.15 - 17.01 (10.692 ± 1.699 x 14.215 ± 1.4091) µm; corpus = 0.247 - 0.288 (0.266 ± 0.012) mm; isthmus = 0.014 - 0.019 x 0.019 - 0.024 (0.0169 ± 0.001 x 0.0203 ± 0.001) mm; end bulb = 0.068 - 0.082 x 0.060 - 0.072 (0.0774 ± 0.004 x 0.0684 ± 0.003) mm; oesophagus = 0.334 - 0.385 (0.3603 ± 0.015) mm; excretory pore = 0.171 - 0.201 (0.186 ± 0.011) mm ; nerve ring = 0.142 - 0.162 (0.149 ± 0.005) mm ; vulva = 0.206 - 0.235 (0.2181 ± 0.008) mm; egg = 70.47 - 80.19 x 36.45 - 43.74 (76.38 ± 3.037 x 40.702 ± 2.236) µm ; tail = 0.097 - 0.131 (0.1203 ± 0.0102) mm.

Paratype males (n = 5)

a = 10.51 - 12.25 (11.01 ± 0.720) ; b = 3.52 - 5.29 (4.626 ± 0.676) ; c = 7.03 - 10.55 (8.532 ± 1.288); L = 0.711 - 1.118 (0.866 ± 0.164) mm; W = 0.058 - 0.088 (0.079 ± 0.016) mm; buccal cavity = 7.29 -11.03 x 4.86 - 7.29 (9.05 ± 1.597 x 6.525 ± 0.994) μm; corpus = 0.109 - 0.153 x 0.014 - 0.019 (0.1284 ± 0.0171 x 0.0176 ± 0.002) mm; isthmus = 0.014 - 0.019 x 0.009 - 0.014 (0.0166 ± 0.002 x 0.0114 ± 0.002) mm; end bulb = 0.034 - 0.053 x 0.031 - 0.046 (0.042 ± 0.008 x 0.0388 ± 0.005) mm; oesophagus = 0.157 - 0.208 (0.187 ± 0.022) mm; excretory pore = 0.291 mm; nerve ring = 0.114 - 0.150 (0.128 ± 0.017) mm; spicule = 36.45 - 38.88 (38.39 ± 1.086) μm; tail = 0.080 - 0.135 (0.102 ± 0.020) mm.

Description

Female: The mature gravid female worm measures 2.865 - 4.74 mm in length and 0.137- 0.216 mm in width. Cuticle strongly annulated from anterior end to the level of vulva. Head with circular oral opening surrounded by 8 labiopapillae and 2 small amphidial apertures. Head and first annule together measures 17.01 -21.87 μm long, 31.59 - 41.31 μm wide. Buccal cavity large, highly sclerotised, 9.72 - 14.58 μm long, 12.15 - 17.01 μm wide. Nerve ring halfway along corpus, 0.147 - 0.162 mm from anterior end. Excretory pore situated immediately in front of the

vulva 0.171 - 0.201 mm from anterior end. Corpus cylindrical, 0.247 - 0.288 mm long, tapering towards anterior end. Isthmus very short, 0.014 - 0.019 mm long, 0.019 - 0.024 mm wide. Endbulb 0.068 - 0.082 mm long, 0.060 - 0.072 mm wide. Oesophagus 0.334 - 0.385 mm long. Cardia distinct. Ovaries two. Eggs elliptical in shape with cuticular crest, 72.9 - 80.19 μm long, 36.45 - 43.74 μm wide. Tail conical, 0.097 - 0.133 mm long.

Male : Worms small, 0.711 - 1.118 mm long, 0.058 - 0.088 mm wide, curved ventrally at the posterior portion upon fixation. Cephalic extremity simple. Cuticle annulated throughout the entire length. Buccal cavity 7.29 -11.03μm long, 0.009 - 0.014 mm wide. Oesophagus 0.157 - 0.208 mm long, more broader towards anterior portion. Nerve ring encircles the corpus just above the level of isthmus, at 0.114 - 0.150 mm from anterior end. Testes single, reflexed at the anterior end a little behind the excretory pore. Spicule single, 36.45 - 38.88 μm long. Caudal papillae consisting of 5 pairs in which 1 pair preanal, 2 pairs adanal, 2 pairs post anal in which 1 pair is situated just behind the anus and 1 pair at caudal appendage. Tail 0.080 - 0.135 mm long, the posterior end modified into a short filiform projection.

Diagnosis and relationships

Protrellus shamimi n.sp. is characterised by presence of 5 pairs of caudal papillae and the caudal appendage is modified into a short filiform projection in male. Female tail bluntly conical and egg bearing cuticular crests.

The new species most closely resemble *P. aurifluus* Choitwood, 1932 in the shape of female tail, eggs, and in the position of vulva, but it differs in having longer male, longer spicule and 5 pairs of caudal papillae (Male = 0.290 mm, spicule = 17 μm, caudal papillae = 2 pairs in *P. aurifluus*).

Type host : *Periplaneta americana*

Habitat : Intestine

Type locality: Imphal, Manipur (North East India)

Type material : Holotype female on slide *Protrellus shamimi* n.sp./8, paratype females on slides *Protrellus shamimi* n.sp. / 1-7, 9-11; paratype males on slides *Protrellus shamimi* n.sp. / 1-5 deposited in the nematode collection of the department of Zoology, Aligarh Muslim University, Aligarh-202002, U.P., India. The new species is designated *Protrellus shamimi* after Prof. M. Shamim Jairajpuri for his valuable contribution in the field of nematode taxonomy.

Key to species of *Protrellus*

1. Female = less than 8.58 mm long.....2

\- Female = 8.58 - 10.37 mm long..... *eurycotesi* Kloss, 1961

2(1). Female tail conical with filiform projection.....3

- Female tail short, no filiform projection.....4

3(2). Female = 2.964 - 4.758 mm; 4 pairs of caudal papillae in male... ..... *dixoni* Zervos,1987b

- Female = 5.6 - 7.66 mm; 3 pairs of caudal papillae in male... ..... *rasolefi* Van Waerebeke, 1969

4(2). Egg with crest or bosses.....5

- Egg without crest or bosses 9

5(4). Female oesophagus = 0.633 mm long..... ..... *kunckeli* (Galeb, 1877) Schwenk, 1926

- Female oesophagus less than 0.633 mm long.....6

6(5). Excretory pore conspicuous.....7

- Excretory pore inconspicuous.... *ischnopterae*(Kloss,1966) Zervos,1987a

7(6). Length of egg = 90 - 95 µm ... ... *manni* (Chitwood, 1932)Chitwood, 1933

- Length of egg less than 90 µm.....8

8(7). Spicule = 17 µm long, 2 pairs of caudal papillae in male..... ..... *aurifluus* (Chitwood, 1932) Basir, 1956

- Spicule = 36.45 – 38.88 µm long, 5 pairs of caudal papillae in male..... ..... *shamimi* n.sp.

9(4). Eggs with lateral grooves..... ..... *phyllodromi* (Basir, 1942) Schikhobalova & Logodovskaya,1966

- Eggs without lateral grooves.....10

10(9). Excretory pore with lip.....11

- Excretory pore without lip.....12

11(10). Eggs larger than 77 µm, Oesophagus = 180 mm and excretory pore = 0.290 mm from anterior end..... *dalei* Zervos, 1987a

- Eggs less than 77 µm, Oesophagus = 0.39-0.43 mm and excretory pore=0.180 mm from anterior end ..... *behorefi* Van Waerebeke, 1969

12(10). Female = 6 mm long, tail acutely pointed..... *aureus* Cobb, 1920

- Female = 5.029-5.147mm long, tail subulate.....

..... *ituana* (Kloss, 1966) Zervos, 1987a

TABLE- 11

Comparative measurement chart of the species of genus *Protrellus*

	P.aureus	*P.aurifluus*	*P.manni*	*P.kunckeli*	*P.phyllodromi*	*P.dixoni*	*P.dalei*	*P.eurycotesi*	*P.ischnopterae*	*P.ituana*	*P.behorefi*	*P.rasolofi*	*P.shamimi* n.sp
	mm*	**mm***	**mm***	**mm***	**mm***	**mm***	**mm***	**mm***	**mm***	**mm***	**mm***	**mm***	**mm**
F													
L	6	3.4-5.2	2.62	5-6	2.3	3.374	2.96-4.75	8.58-10.37	4.120	5.02-5.14	3.4-5.65	5.6-7.660	2.865-4.74
W	0.1	0.11-0.16	0.1	0.30	0.16	0.187	0.250	0.25-0.34	0.171	0.182	0.18-0.33	0.159-0.179	0.137-0.216
O	0.438	0.27-0.38	0.39	0.633	0.30	0.406	0.180	0.49-0.507	0.408	0.37-0.39	0.39-0.43	0.45-0.478	0.334-0.385
EP	-	-	0.179	-	0.150	0.254	0.290	-	-	-	0.180	0.104	0.171-0.201
NR	-	0.07-0.09	-	-	0.130	0.176	0.190	0.233	-	0.10-0.11	-	0.180	0.147-0.162
v	0.318	0.17-0.25	0.23	0.566	-	0.285	0.3	0.26-0.33	0.128	0.16-0.17	0.19-0.21	0.21-0.32	0.206-0.235
e	104x50	85-90x36-	90-95x 40-	130-180x	75x35mm	-	98x45µm	72-81x39-	78x36µm	75x36mm	72-77x34-	65-73x38-	72.9-
80.19x36.45													
	µm	41µm	45µm	70-100µm				48µm			40µm	45µm	- 43.74µm
T	0.188	0.1-0.209	0.104	0.233	0.145	0.373	0.10	0.20-0.22	-	-	-	-	0.097-0.133
M													
L	0.610	0.290	-	0.8-1.0	-	0.725	1.148	-	-	-	-	0.755	0.711-1.118
W	0.04	0.018	-	0.087	-	0.039	0.056	-	-	-	-	0.058	0.058-0.088
O	0.138	0.073	-	0.207	-	0.129	0.180	-	-	-	-	0.102	0.157-0.208
EP	-	-	-	-	-	0.132	0.20	-	-	-	-	-	0.291
NR	0.061	-	-	-	-	-	0.110	-	-	-	-	-	0.114-0.150
S	-	17µm	-	50µm	-	27µm	24µm	-	-	-	-	-	36.45-38.88µm
CP	3pairs	2pairs	-	-	-	4pairs	3pairs	-	-	-	-	3pairs	5pairs
T	0.061	0.032	-	-	-	-	0.060	-	-	-	-	0.039	0.080-0.135

*All measurements from original descriptions

Abbreviation used : F = Female, L = length, W = width, O = oesophagus, EP = Excretory pore, NR = nerve ring, v = vulva, e = egg, T = tail, S = spicule, CP = caudal papilla M=male

FIGURES

Fig. 1 ***Thelastoma periplaneticola*** **Leibersperger, 1960**

A - Female anterior end

B - Female oesophageal region

C - Female vulval region showing lip

D - Female posterior end (lateral view)

E - Male entire

F - Male anterior end

G - Male posterior end (lateral view)

H - Egg

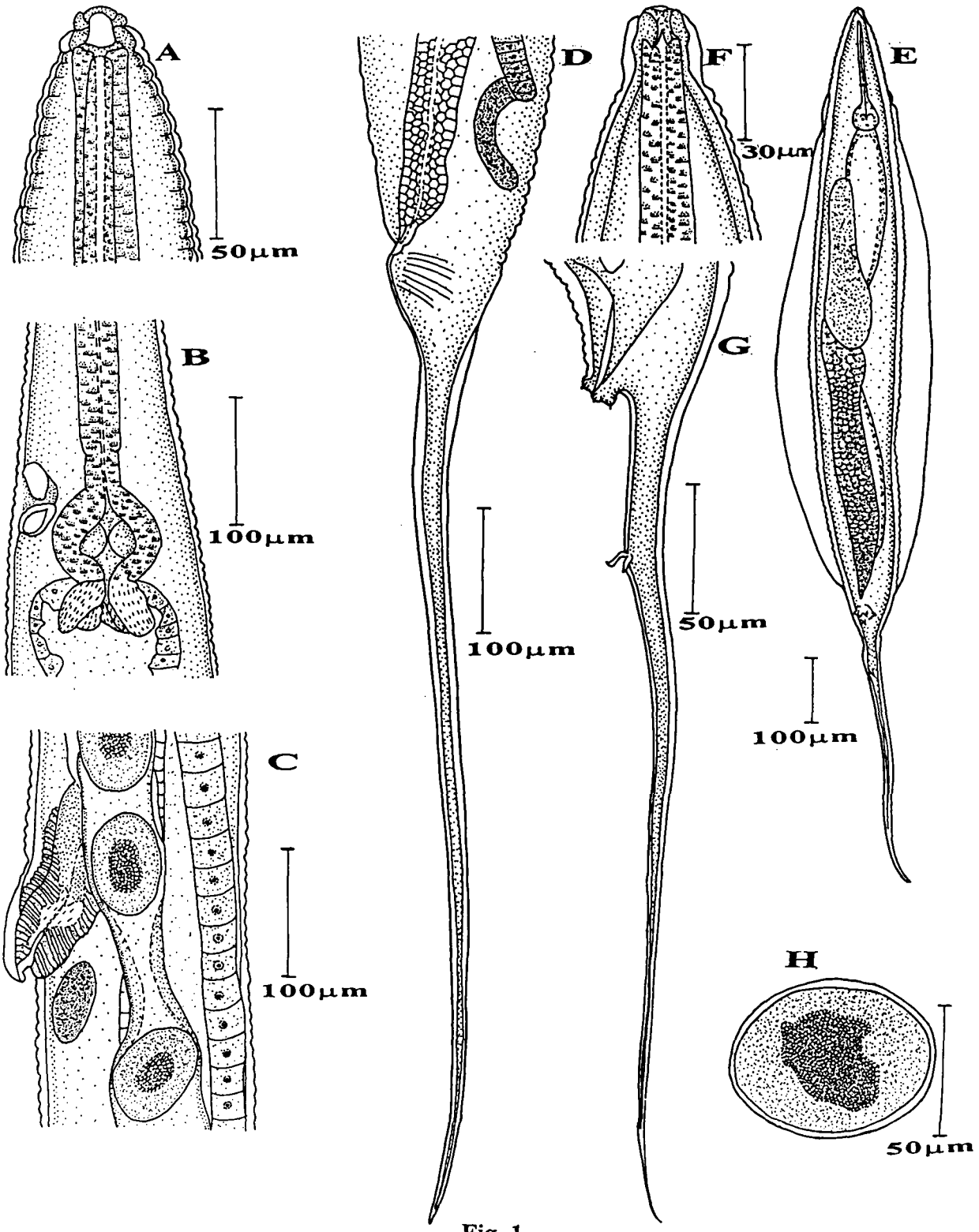


Fig. 1

Fig. 2 ***Leidynema appendiculatum*** **Leidy,1850**

A - Female anterior end

B - Female head end

C - Female showing intestinal diverticulum

D - Female posterior end (lateral view)

E - Female posterior end (ventral view)

F - Male head end

G - Male posterior end (lateral view)

H - Male posterior end (ventral view)

I - Eggs

J - Spicule

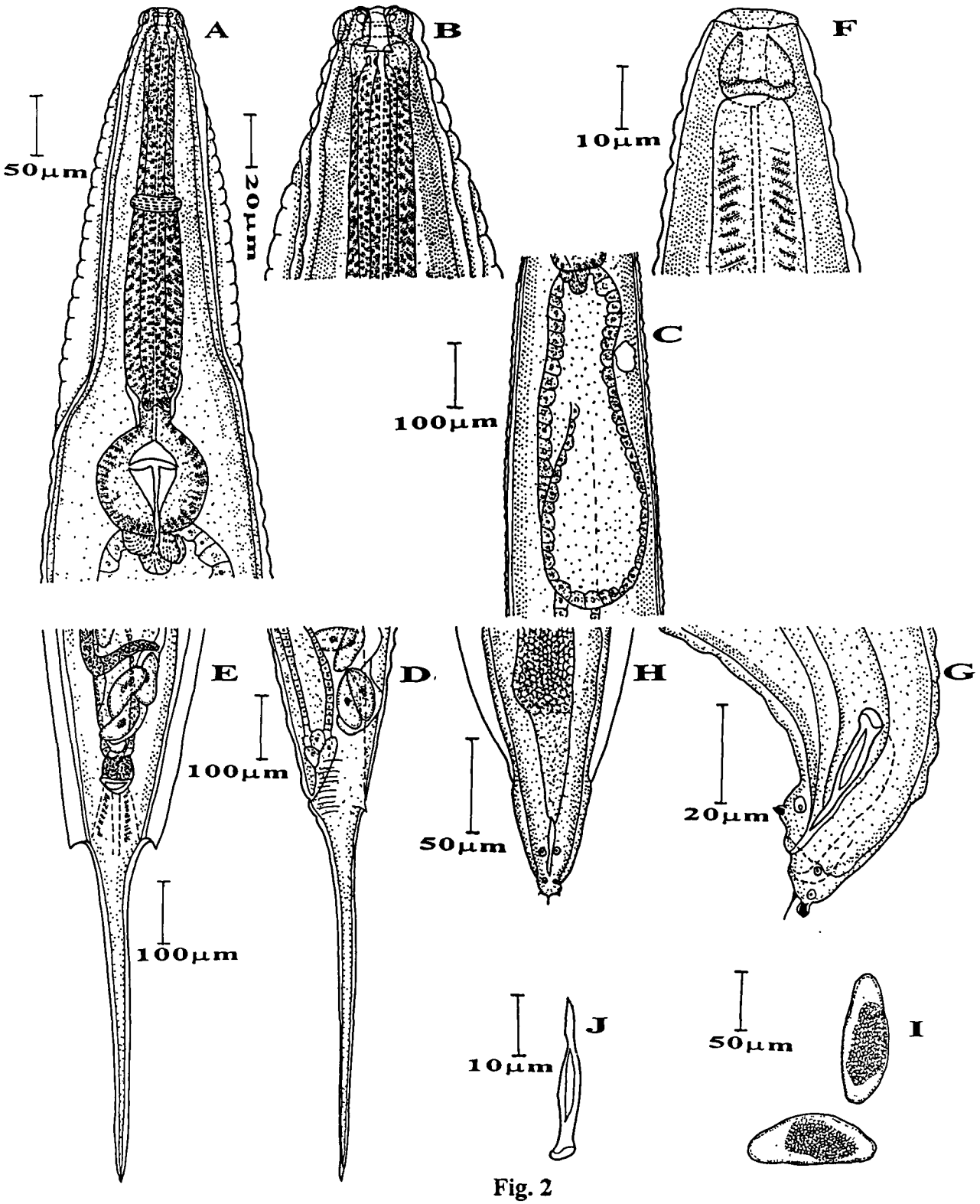

A
50µm
20µm
B
100µm
F
10µm
C
E
100µm
100µm
D
H
50µm
G
20µm
J
10µm
50µm
I

Fig. 2

Fig. 3 ***Gryllophila skrjabini*** **Sergiev,1923**

A - Female anterior end

B - Female posterior end (lateral view)

C - Female head end

D - Male anterior end

E - Male posterior end (lateral view)

F - Male head end

G - Spicule (lateral view)

I - Spicule (ventral view)

I - Eggs

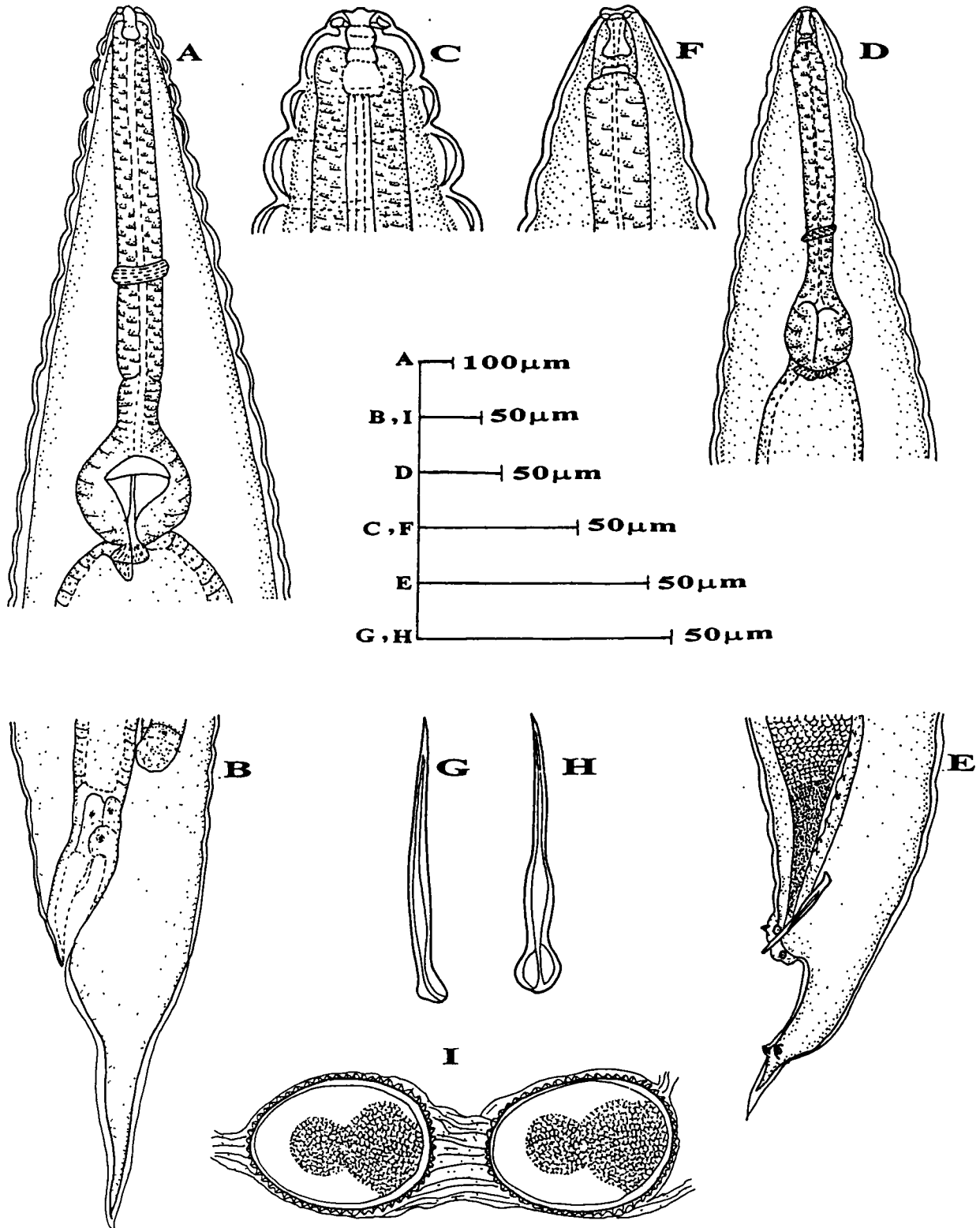


Fig. 3

Fig. 4 ***Hammerschmidtiella diesingi*** **Hammerschmidt,1838**

A - Female anterior end

B - Female head end

C - Female posterior end (lateral view)

D - Female tail tip showing cap like structure

E - Male anterior end

F - Male posterior end (ventral view)

G - Male posterior end (lateral view)

H - Eggs

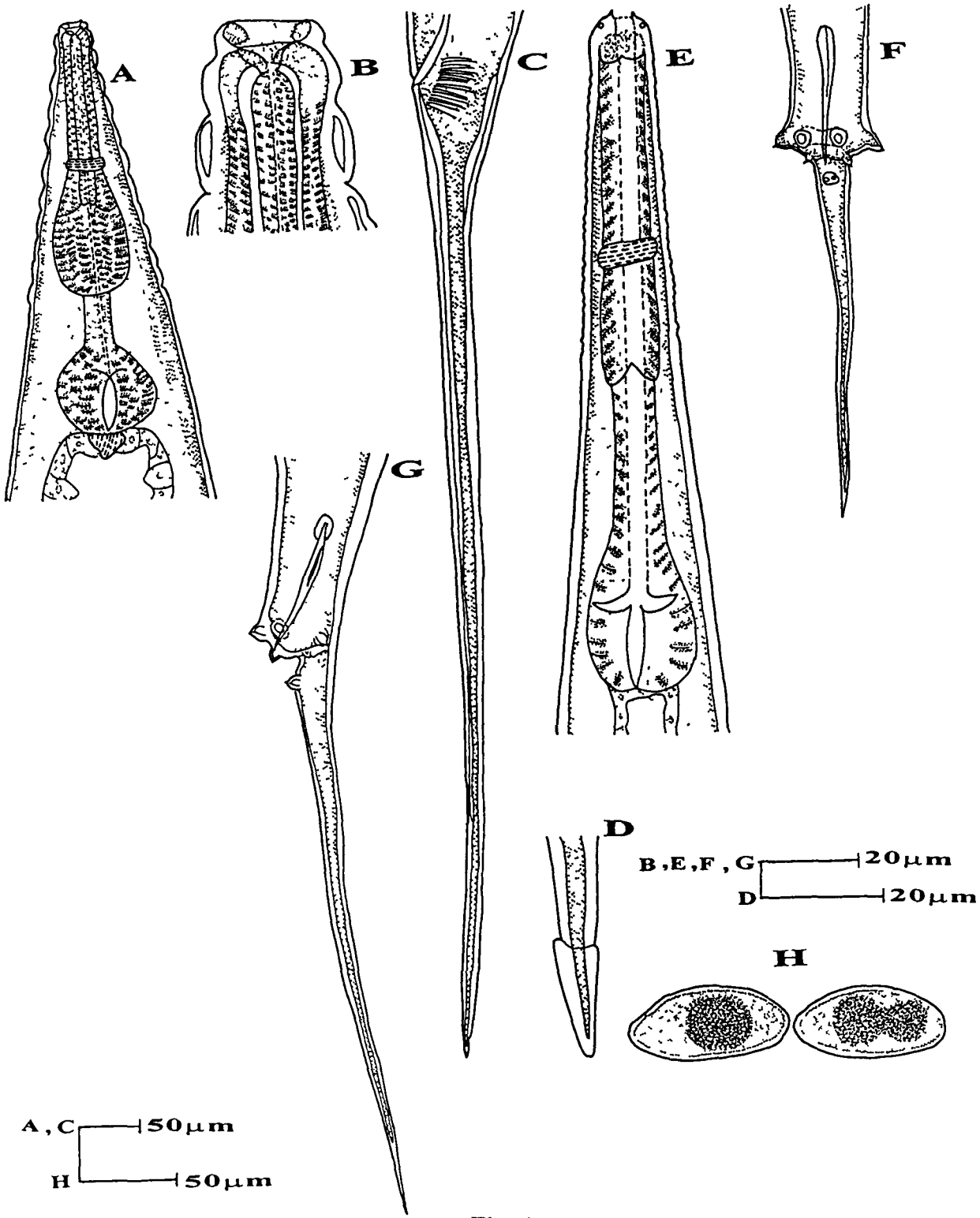


Fig. 4

Fig. 5 ***Cameronia triovata*** **n.sp.**

A - Female anterior end

B - Female vulval region

C - Female posterior end (lateral view)

D - Female head end

E - Eggs

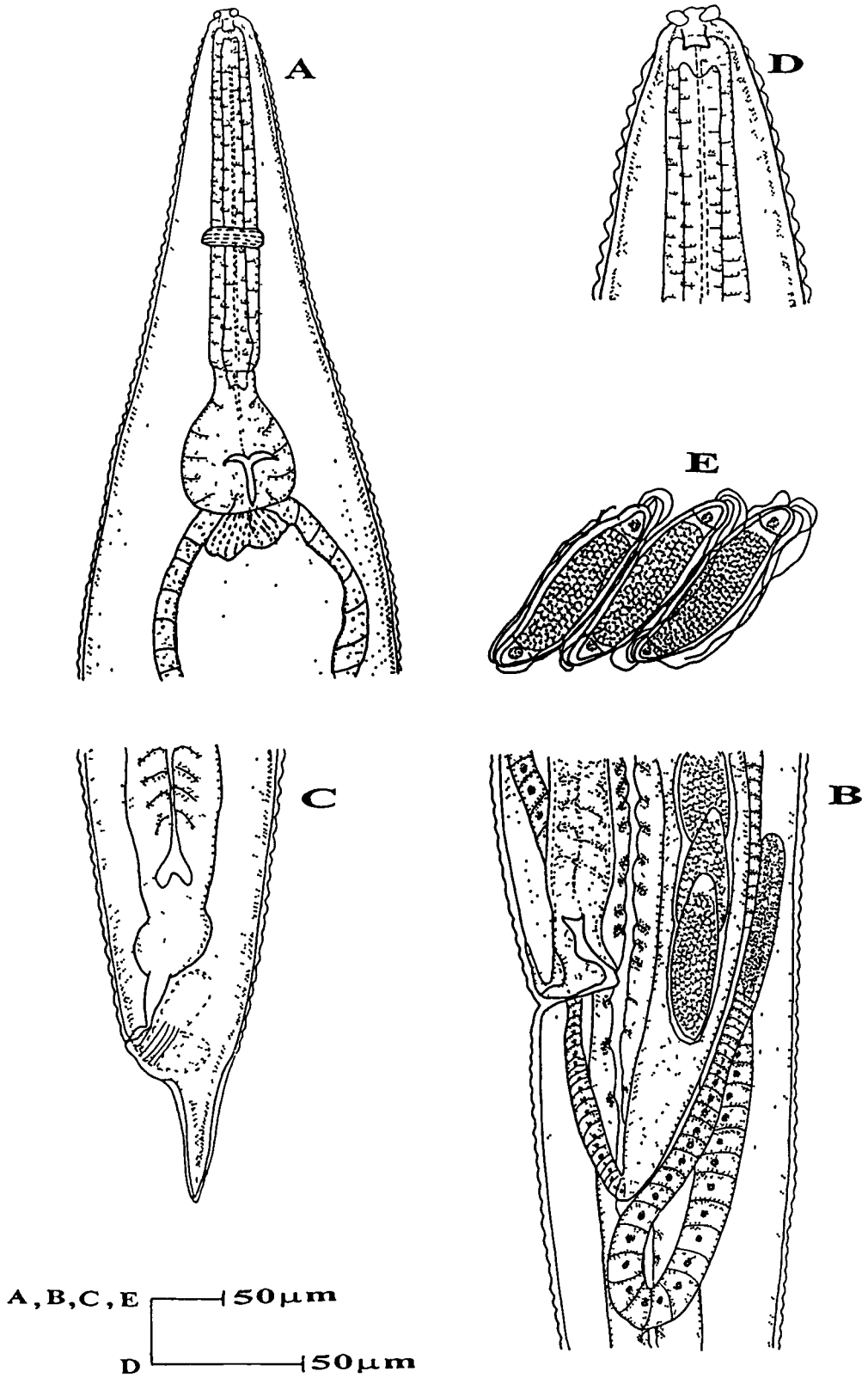


Fig. 5

Fig. 6 ***Cameronia manipurensis*** **n.sp.**

A - Female anterior end

B - Female head end

C - Female posterior end (lateral view)

D - Male anterior end

E - Male head end

F - Male posterior end (lateral view)

G - Male posterior end (ventral view)

H - Eggs

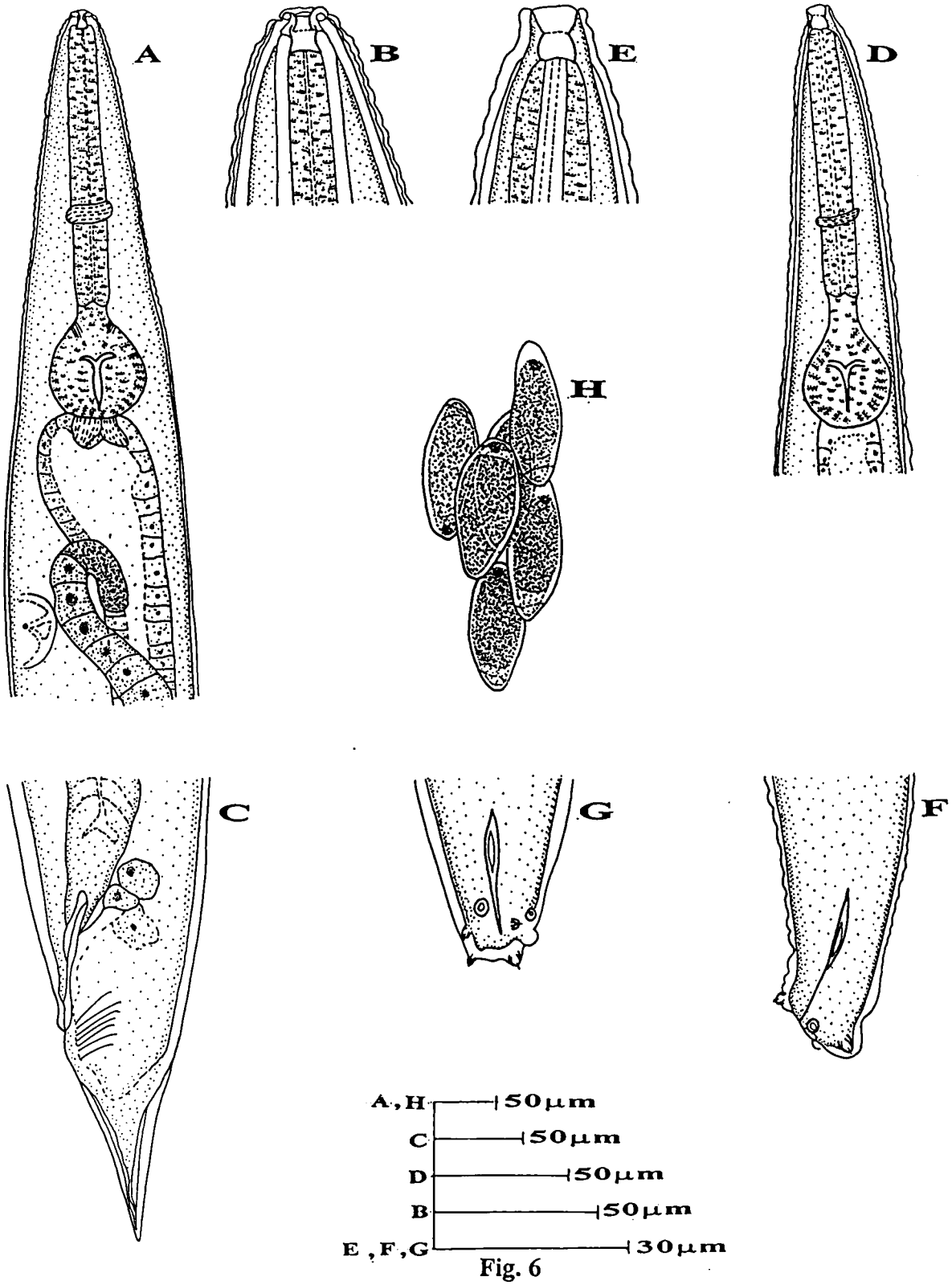


Fig. 6

Fig. 7 ***Chitwoodiella ovofilamenta*** **Basir,1948**

A - Female anterior end

B - Female vulval region

C - Female posterior end (lateral view)

D - Female head end

E - Male head end

F - Male oesophageal region

G - Male posterior end (lateral view)

H - Male posterior end (ventral view)

I - Eggs

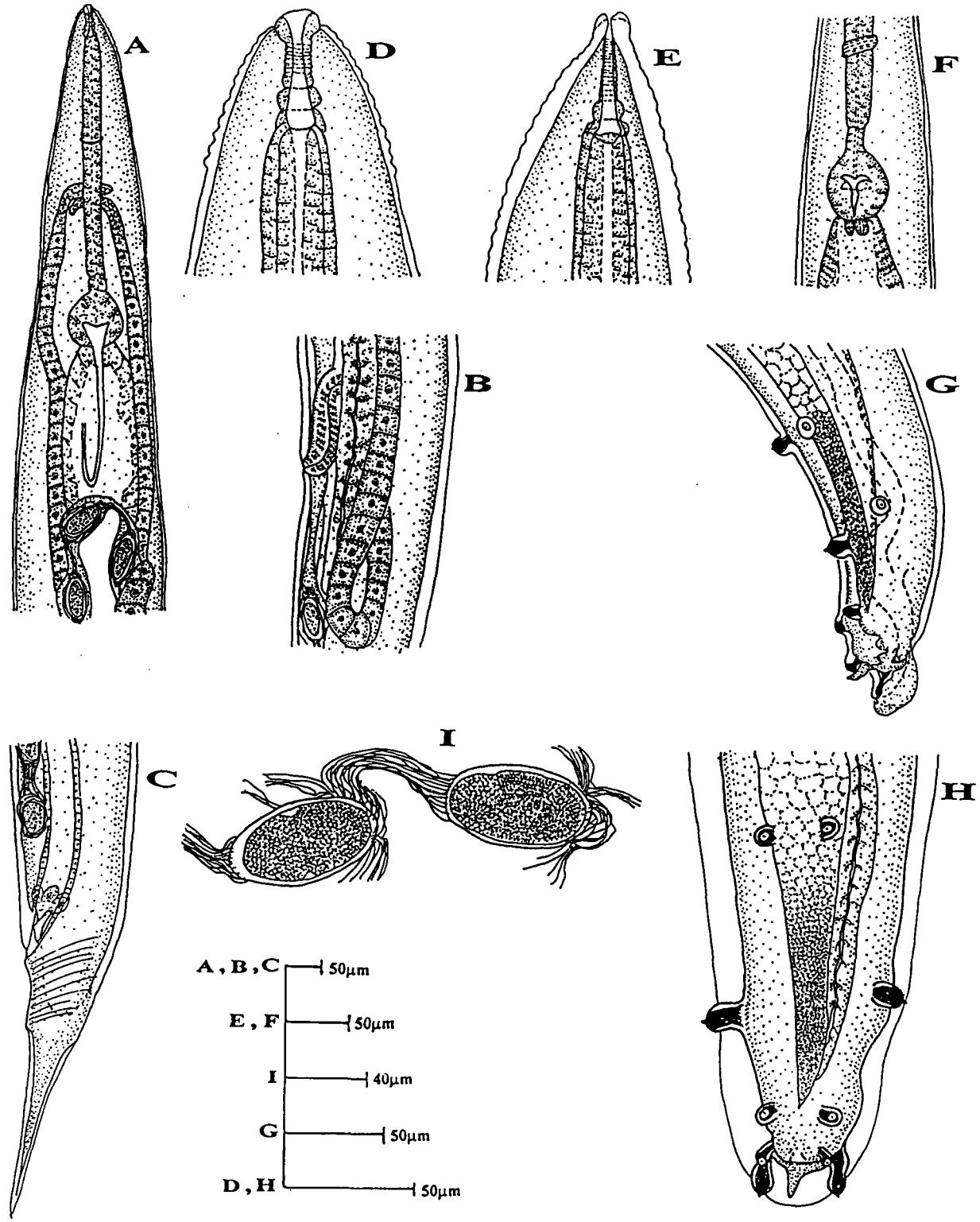


Fig. 7

Fig. 8 ***Binema ornata*** **Travassos, 1925**

A - Female anterior end

B - Female posterior end (lateral view)

C - Female head end

D - Male anterior end

E - Male posterior end (lateral view)

F - Male head end

G - Spicule

H - Eggs

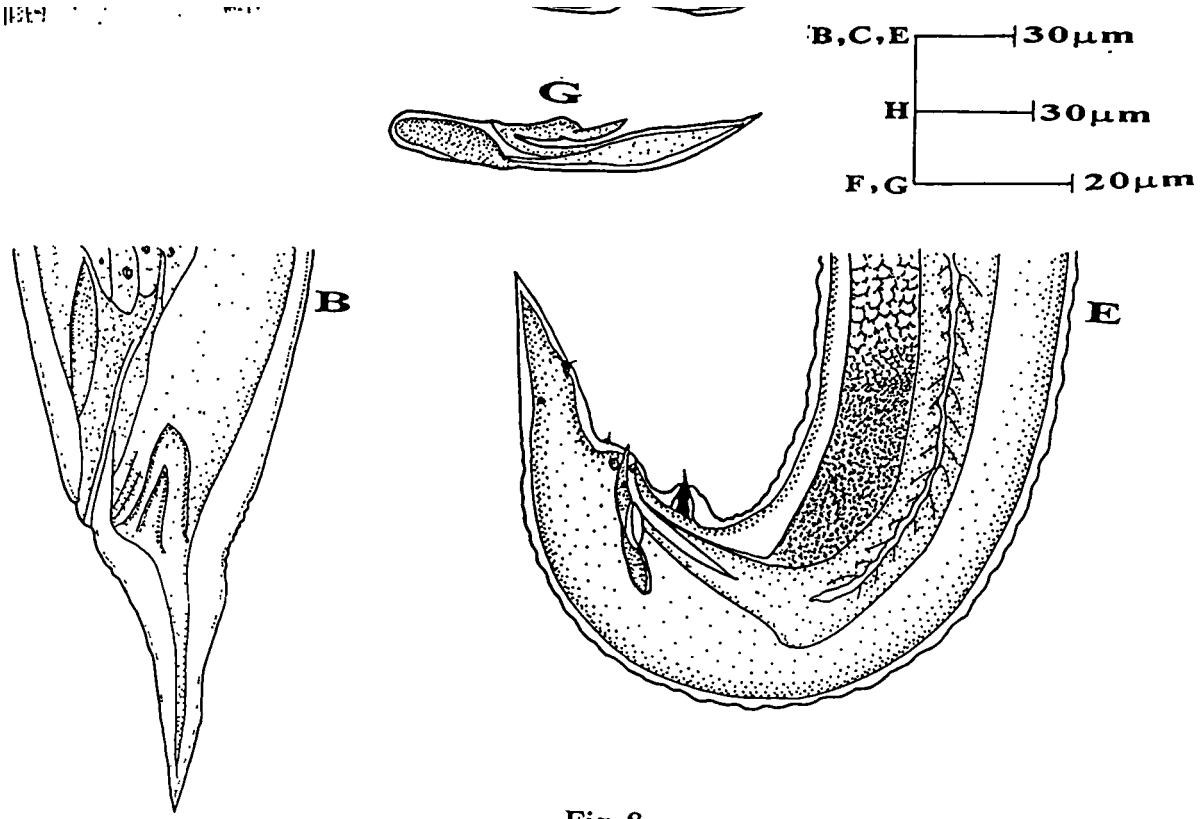


Fig. 8

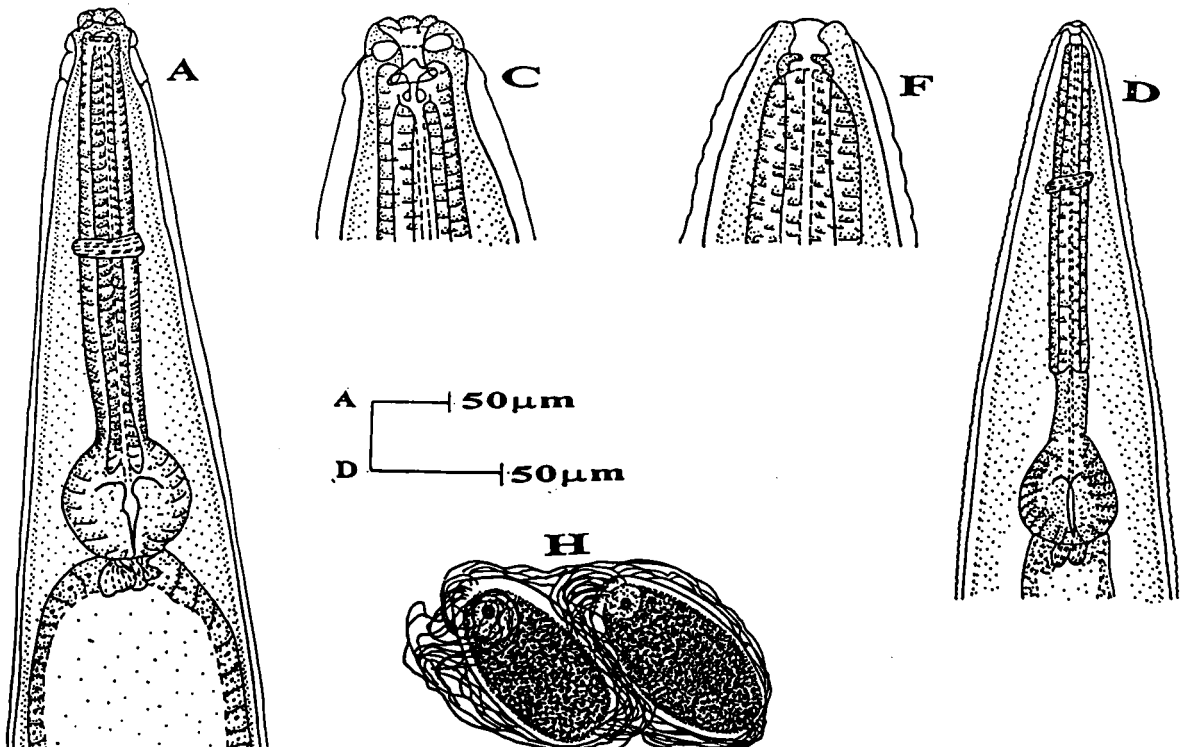

A
C
F
D
A
50µm
D
50µm
H

Fig. 9 ***Binema korsakowi*** **Sergiev, 1923**

A - Female anterior end

B - Female vulval region

C - Female posterior end (lateral view)

D - Male head end

E - Male anterior end

F - Male posterior end (lateral view)

G - Male head end

H - Spicule

I - Eggs

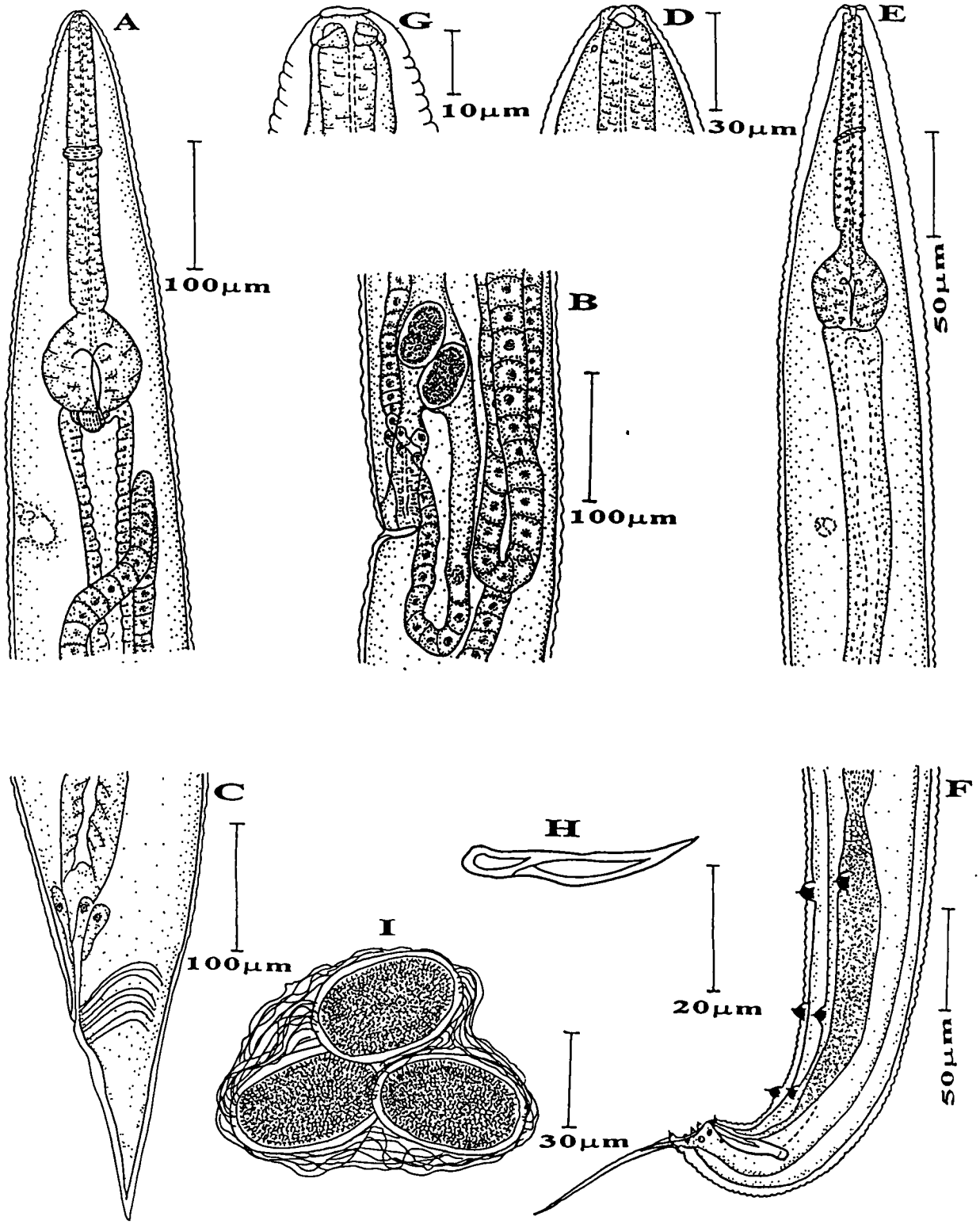


Fig. 9

Fig. 10 ***Binema mirzaia*** **Basir, 1942**

A - Female anterior end

B - Female head end

C - Male head end

D - Male anterior end

E - Female posterior end (lateral view)

F - Male posterior end (lateral view)

G - Male posterior end (ventral view)

I - Eggs

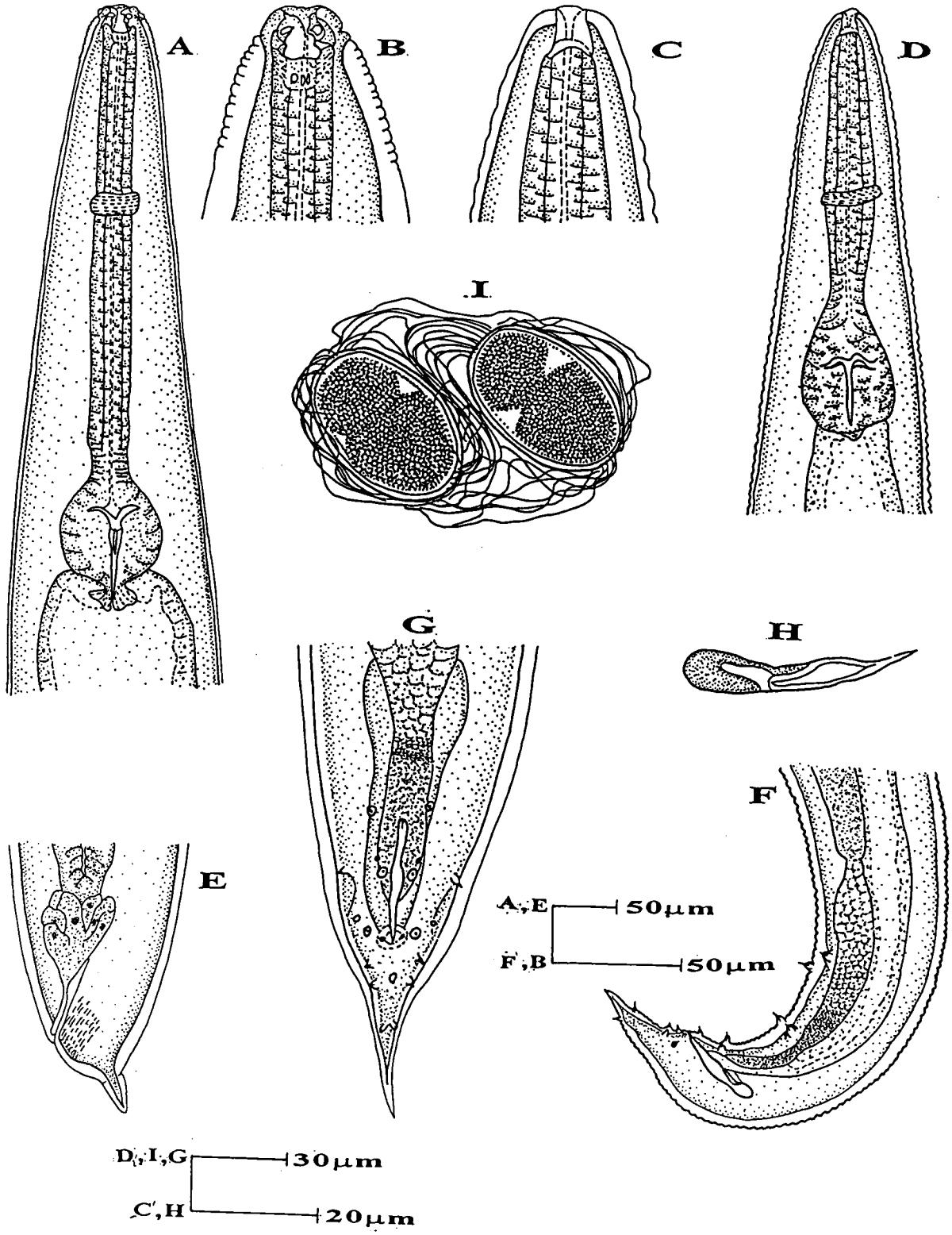


Fig. 10

Fig. 11 ***Binema anulinervus*** **n.sp.**

A - Female anterior end

B - Female head end

C - Female posterior end (lateral view)

D - Male entire (lateral view)

E - Male head end

F - Male posterior end (lateral view)

G - Male posterior end (ventral view)

H - Egg

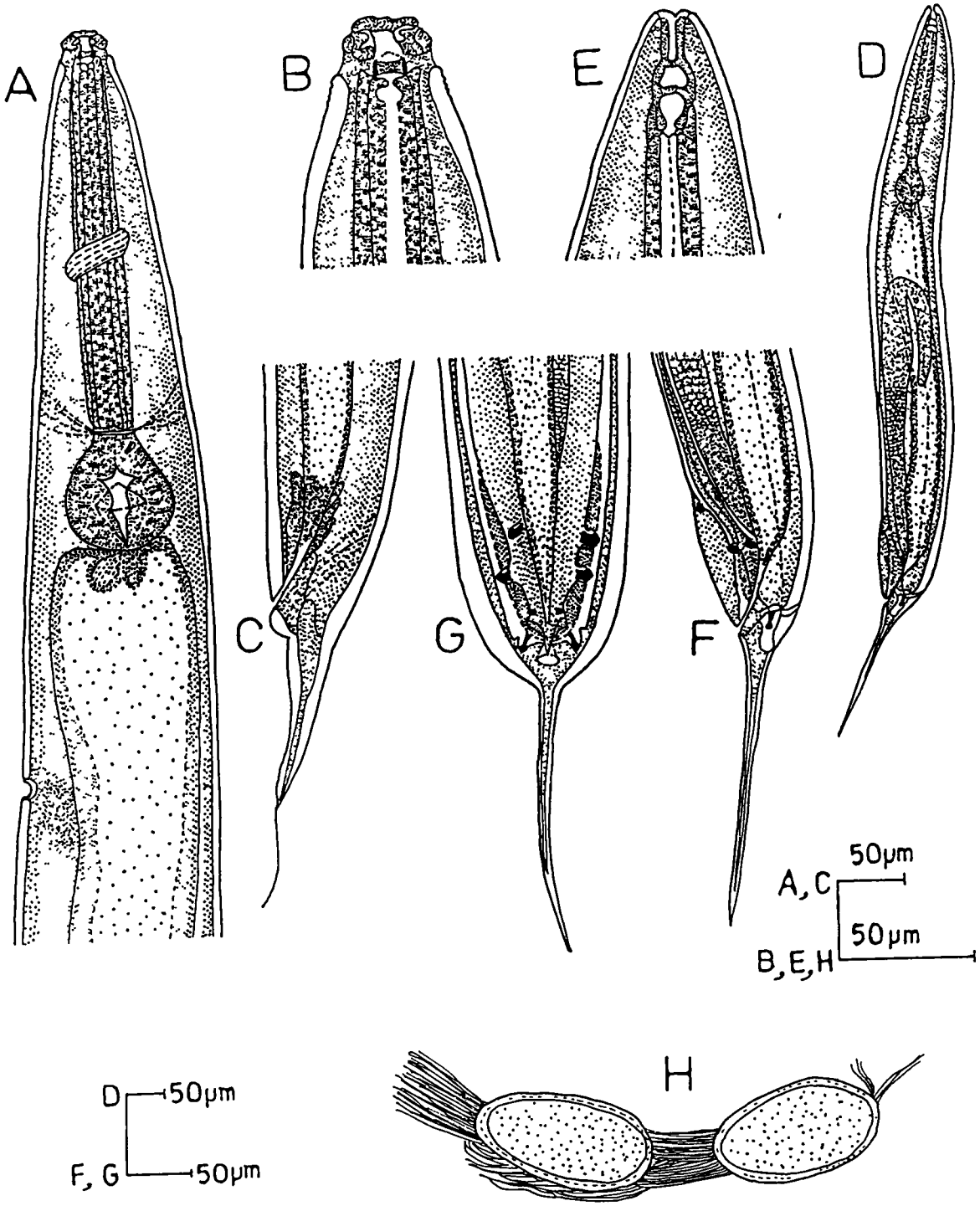


Fig. 11

Fig. 12 ***Mirzaiella asiatica*** **Basir, 1942**

A - Female anterior end

B - Female posterior end (lateral view)

C - Female head end

D - Male anterior end

E - Male posterior end (lateral view)

F - Male head end

G - Male posterior end (ventral view)

H - Eggs

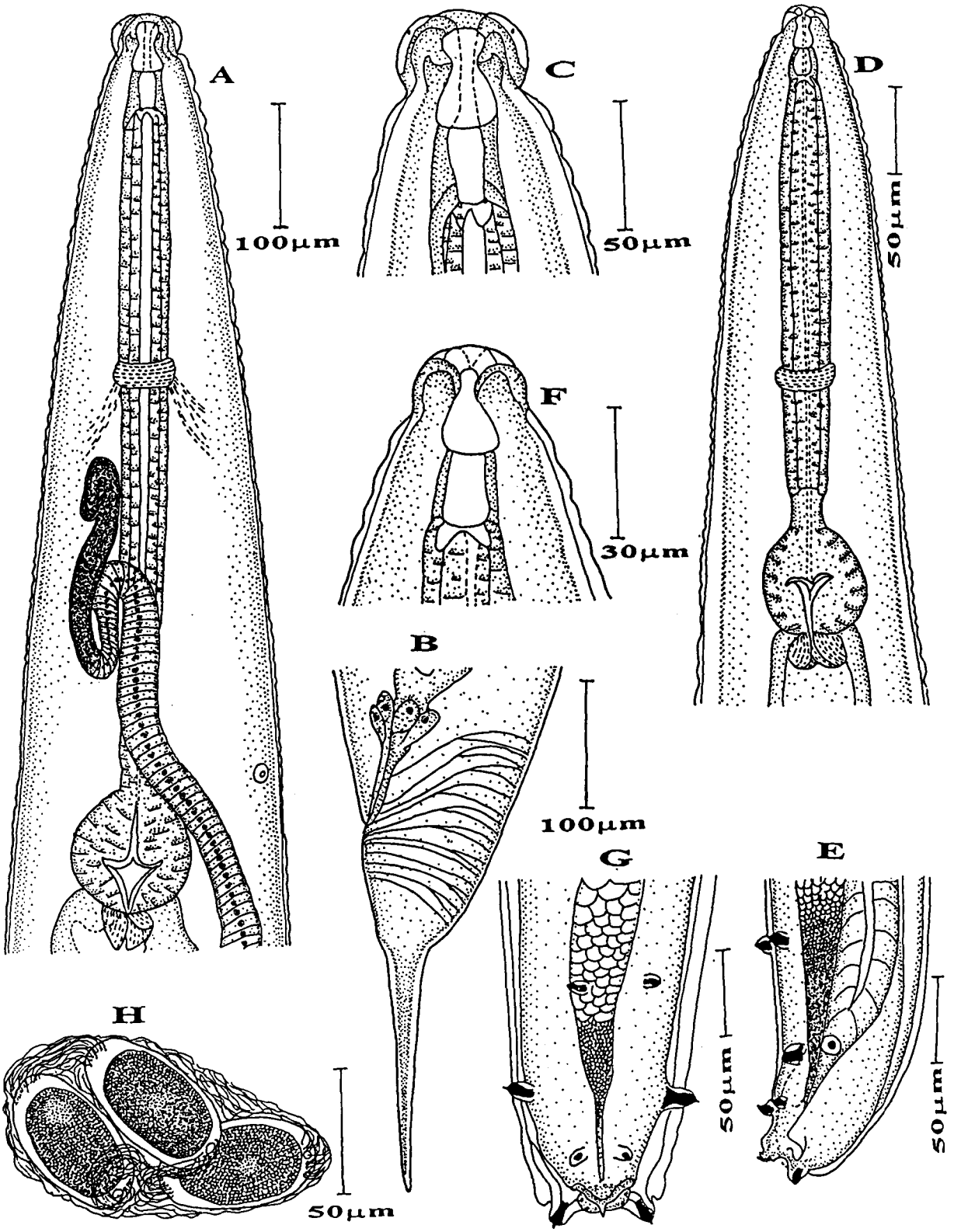


Fig. 12

Fig. 13 ***Pseudonymus basiri*** **n.sp.**

A - Female anterior end

B - Female vulval region showing lip

C - Female posterior end (lateral view)

D - Female head end

E - Male anterior end

F - Male posterior end (lateral view)

G - Male head end

H - Male posterior end (ventral view)

I - Spicule

J - Egg

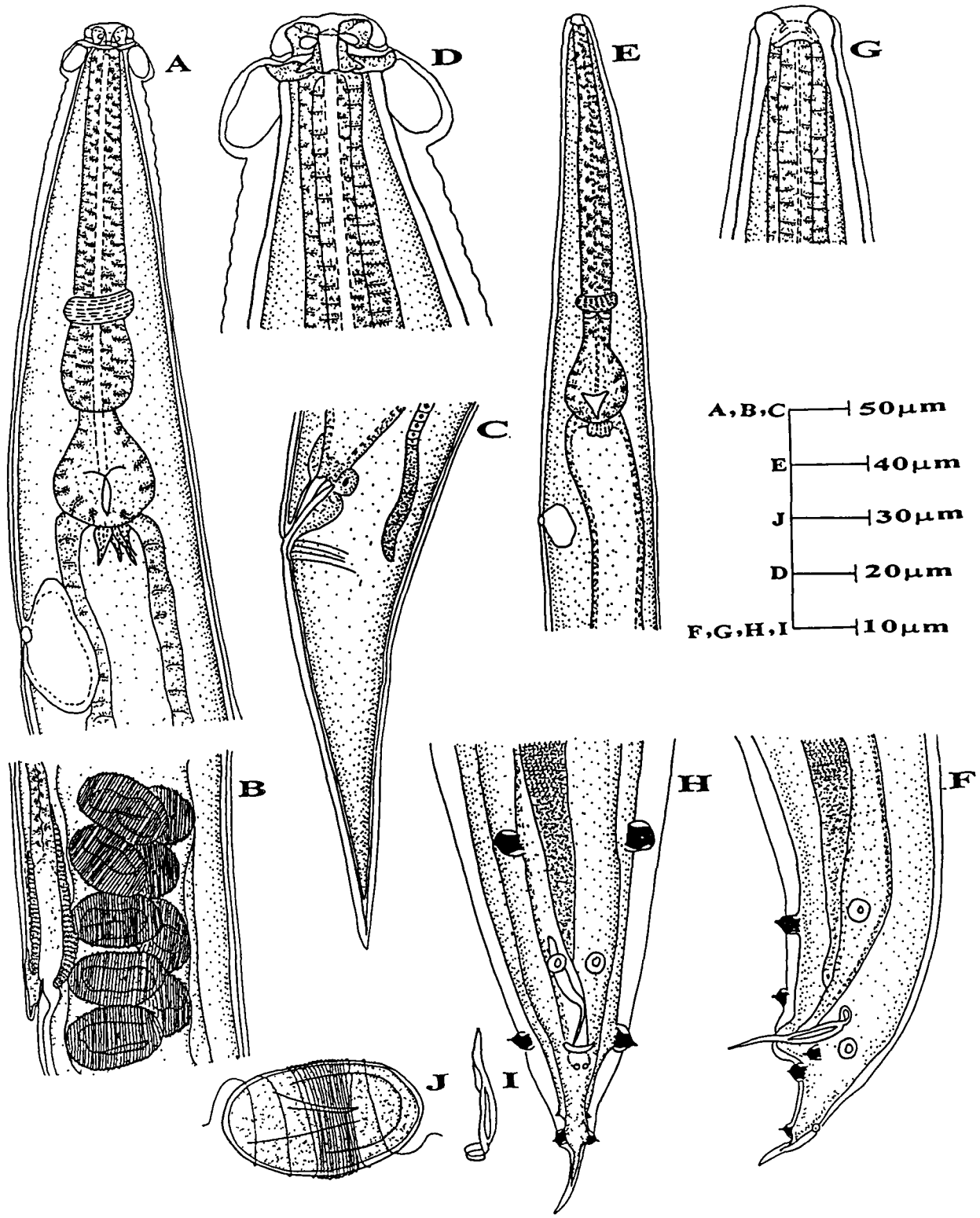


Fig. 13

Fig. 14 ***Zonothrix imphali*** **n.sp.**

A - Female anterior end

B - Female posterior end (lateral view)

C - Female head end

D - Female vulval region showing lip

E - Egg

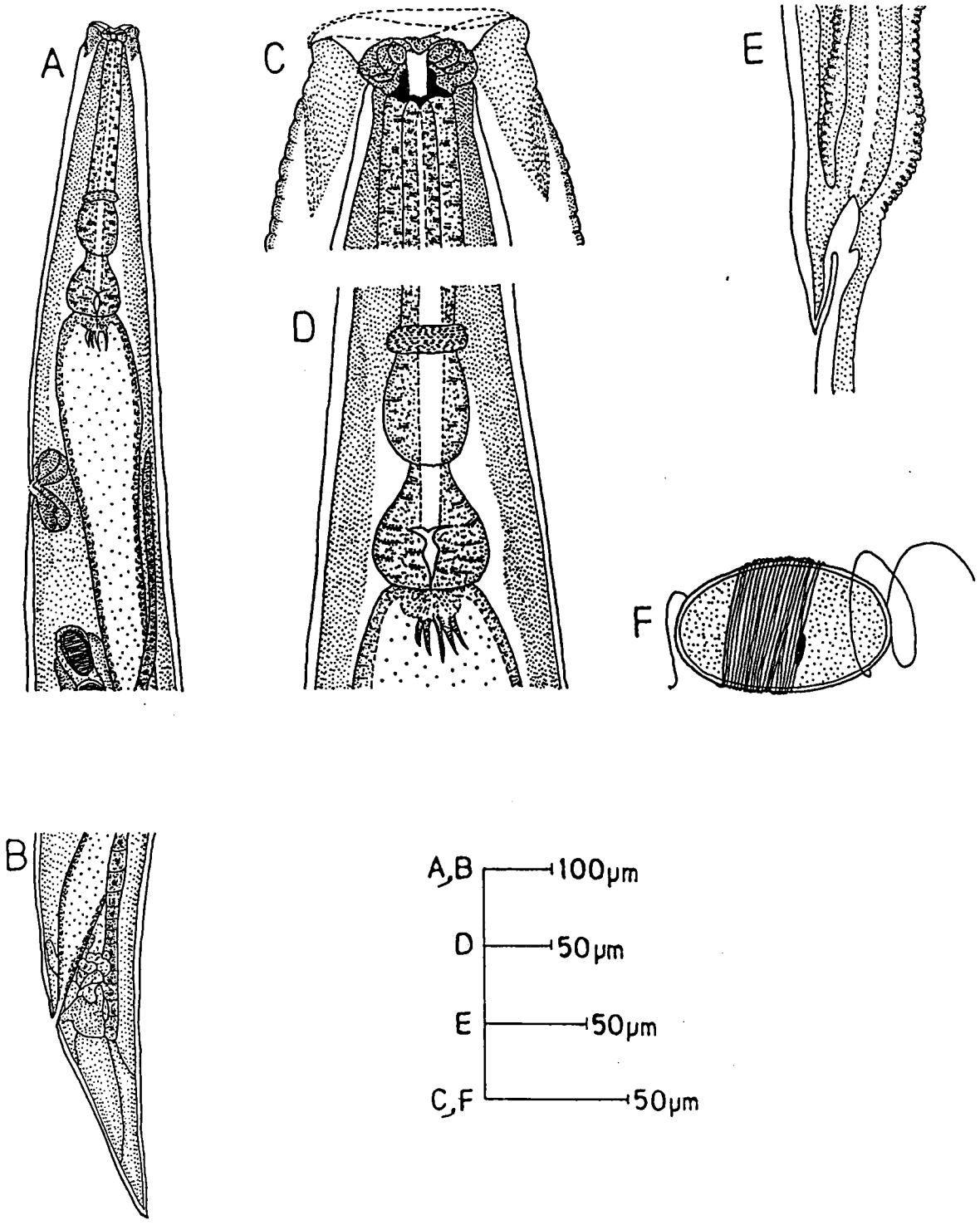


Fig. 14

Fig. 15 ***Protrellus shamimi*** **n.sp.**

A - Female anterior end

B - Female posterior end (lateral view)

C - Female head end

D - Male entire (lateral view)

E - Male posterior end (lateral view)

F - Male head end

G - Eggs

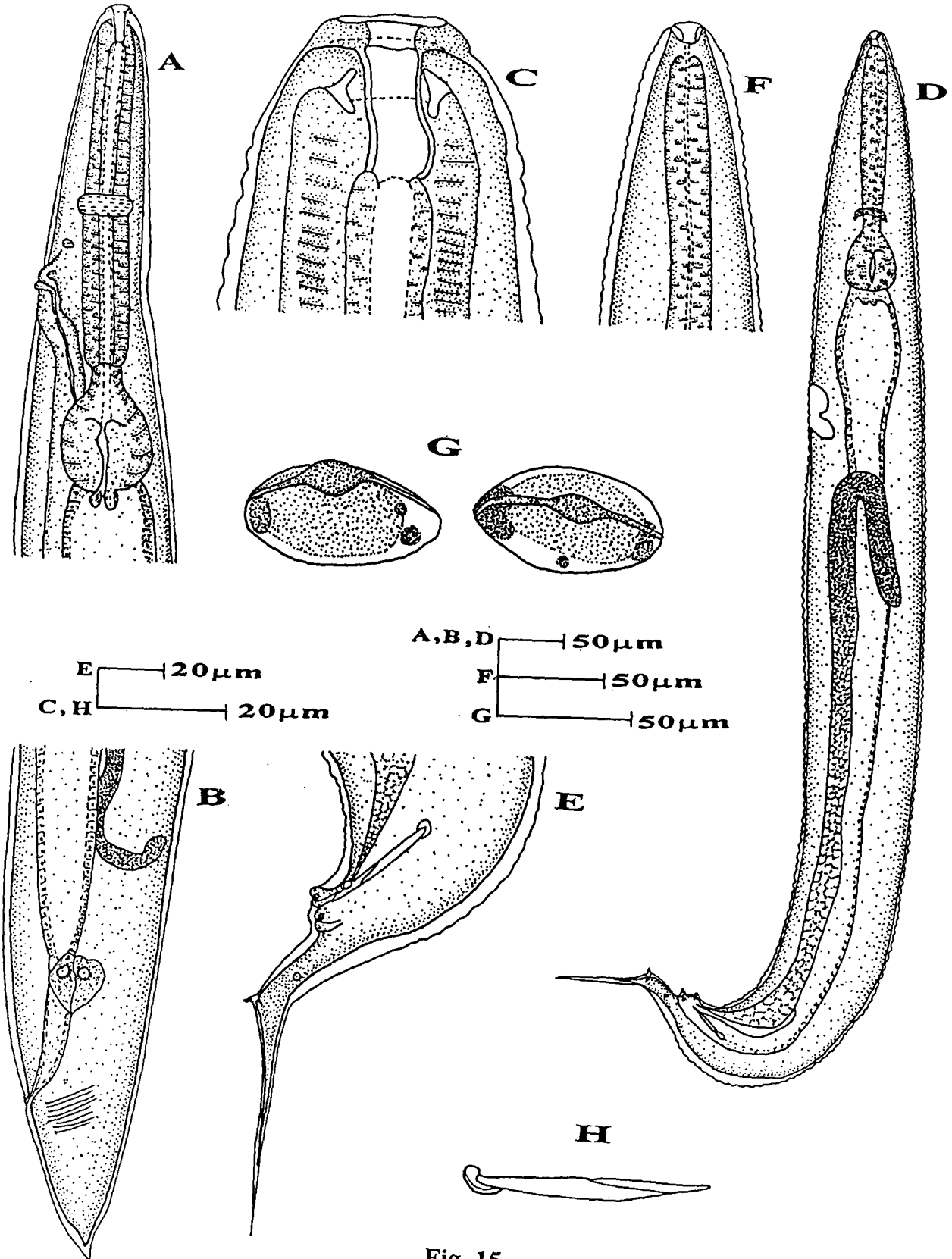


Fig. 15

CONCLUSION

During the course investigation of various insect hosts from August, 1999 to January, 2002, for the parasitic infection by the members of the superfamily Thelastomatoidea, the following conclusions are drawn:

1. The investigation of parasitic infection in various insect hosts revealed that 4 families of the superfamily Thelastomatoidea viz., Thelastomatidae Travassos,1929, Travassosinematidae Rao,1958, Pseudonymidae Kloss,1958 and Protrelloididae Chitwood,1932 generally parasitize them. Key to the genera of these four families have been provided for the first.

2. The members of the above 4 families are parasitic in 3 host insects viz., *Gryllotalpa africana, Periplaneta americana* and *Hydrophilus triangularis* in the North Eastern Part of India.

3. Parasitism by the members of the superfamily Thelastomatoidea revealed 15 species of nematodes. The nematodes belong to 11 known genera, 6 new species and 9 known species, all of which are reported for the first time from North East India. In addition, the diagnoses of 10 genera has been emended. Identification keys to the species of 8 genera have been provided after modification except for the genus *Pseudonymus* which is provided for the first time. Comparative measurement charts of new as well as known species of 8 genera have also been provided.

Phylum: Nematoda

Class : Secernentea

Order : Oxyurida

Superfamily : Thelastomatoidea

4. The families identified are:

    1. Thelastomatidae Travassos, 1929
    2. Travassosinematidae Rao,1958
    3. Protrelloididae Chitwood,1932
    4. Pseudonymidae Kloss,1958

5. The genera identified are:

    1. *Binema* Travassos, 1925
    2. *Cameronia* Basir, 1948
    3. *Chitwoodiella* Basir, 1948
    4. *Gryllophila* Basir, 1942
    5. *Hammerschmidtiella* Chitwood, 1932
    6. *Leidynema* Schwenk in Travassos,1929
    7. *Mirzaiella* Basir,1942
    8. *Protrellus* Cobb, 1920
    9. *Pseudonymus* Diesing, 1857
    10. *Zonothrix* Todd,1942
    11. *Thelastoma* Leidy,1849

6. The new species are:

1. *Cameronia triovata* n.sp.
2. *Cameronia manipurensis* n.sp.
3. *Binema anulinervus* n.sp.
4. *Pseudonymus basiri* n.sp.
5. *Protrellus shamimi* n.sp.
6. *Zonothrix imphali* n.sp.

7. The known species are:

1. *Binema mirzaia* Basir,1942
2. *Binema korsakowi* Sergiev,1923
3. *Binema ornata* Travassos,1925
4. *Chitwoodiella ovofilamenta* Basir,1948
5. *Gryllophila skrjabini* Sergiev,1923
6. *Hammerschmidtiella diesingi* Hammerschmidt, 1838
7. *Leidynema appendiculatum* Leidy,1850
8. *Mirzaiella asiatica* Basir,1942
9. *Thelastoma periplaneticola* Leibersperger,1960

8 Family-wise distribution of nematodes :

a. The family Thelastomatidae is represented by 6 species of nematodes under 5 genera, i.e., *Thelastoma periplaneticola* Leibersperger,1960; *Cameronia triovata* n.sp.; *C.manipurensis* n.sp.; *Gryllophila skrjabini* Sergiev, 1923;

Hammerschmidtiella diesingi Hammerschmidt,1838; *Leidynema appendiculatum* Leidy,1850.

b. The family Travassosinematidae is also represented by 6 species of nematodes belonging to 3 genera, i.e., *Binema ornata* Travassos,1925; *B. mirzaia* Basir,1942; *B. korsakowi* Sergiev,1923; *B. anulinervus* n.sp.; *Mirzaiella asiatica* Basir,1942; *Chitwoodiella ovofilamenta* Basir,1948.

c. The family Pseudonymidae is represented by 2 species of nematodes under 2 genera, i.e., *Pseudonymus basiri* n.sp., *Zonothrix imphali* n.sp.

d. The family Protrelloididae is represented by a single species of nematode namley, *Protrellus shamimi* n.sp.

9. First record from North East India:

1. *Binema mirzaia* Basir, 1942
2. *Binema korsakowi* Sergiev,1923
3. *Binema ornata* Travassos,1925
4. *Chitwoodiella ovofilamenta* Basir,1948
5. *Gryllophila skrjabini* Sergiev,1923
6. *Hammerschmidtiella diesingi* Hammerschmidt,1838
7. *Leidynema appendiculatum* Leidy, 1850
8. *Mirzaiella asiatica* Basir, 1942
9. *Thelastoma periplanetícola* Leibersperger,1960

10. Generic diagnosis emended are:

    1. *Thelastoma* Leidy, 1849
    2. *Gryllophila*, Basir,1942
    3. *Cameronia* Basir,1948
    4. *Binema* Travassos,1925
    5. *Leidynema* Schwenk in Travassos,1929
    6. *Chitwoodiella* Basir,1948
    7. *Pseudonymus* Diesing,1857
    8. *Zonothrix* Todd,1942
    9. *Protrellus* Cobb,1920
    10. *Hammerschmidtiella* Chitwood,1932

11. Key to the genera of the following families have been provided for the first time.

    a) Thelastomatidae Travassos, 1929
    b) Travassosinematidae Rao,1958
    c) Pseudonymidae Kloss,1958
    d) Protrelloididae Chitwood,1932

12. Key to the species of the following genera have been provided (after modification)

    a) *Leidynema* Schwenk(in Travassos, 1929)
    b) *Gryllophila* Basir,1942

c) *Cameronia* Basir,1948

d) *Chitwoodiella* Basir,1948

e) *Binema* Travassos,1925

f) *Mirzaiella* Basir,1942

g) *Zonothrix* Todd,1942

h) *Protrellus* Cobb,1920

13. Key to the species of the genus *Pseudonymus* Diesing, 1857 has been provided for the first time.

14. Comparative measurement chart of the species of the following genera have been provided.

a) *Leidynema* Schwenk in Travassos,1929

b) *Gryllophila* Basir,1942

c) *Cameronia* Basir,1948

d) *Chitwoodiella* Basir,1948

e) *Binema* Travassos,1925

f) *Mirzaiella* Basir,1942

g) *Pseudonymus* Diesing,1857

h) *Protrellus* Cobb,1920

15. Mole cricket (*Gryllotalpa africana*) harboured 5 genera and 9 species, out of which 3 are new and have been described in the present work. American cockroach (*Periplaneta americana*) harboured 4 genera and 4 species, out of

which one species is new to science. Aquatic beetle (*Hydrophilus triangularis*) harboured two new species belonging to the genera *Pseudonymus* and *Zonothrix* respectively.

16. % Infection of nematodes in the three insect hosts during three seasons are as follows:

August - October	-	*H.triangularis>G.africana>P.americana*
September - November	-	*H.triangularis>G.africana>P.americana*
November - January	-	*G.africana>H.triangularis>P.americana*

17. Host-wise distribution of the 4 families of the superfamily Thelastomatoidea are as indicated:

G. africana	-	Thelastomatidae, Travassosinematidae
P. americana	-	Protrelloididae, Thelastomatidae
H. triangularis	-	Pseudonymidae

18. Worm burden in the three insect hosts in three seasons are given below:

August- October - *H. triangularis* (19±14), *G. africana* (9±4) and *P. americana* (8±3)

September-November- *H. triangularis* (9.78±6.42), *G. africana* (7.08 ±5.22) and *P. americana* (11.8±77.4)

November-January - *H. triangularis* (7), *G. africana* (3.32±1.92) and *P. americana* (9.4 ± 2.1)

Nematode show a great degree of host specificity. The phenomenon of host specificity may be due to the fact that every animal has its own optimal conditions of existence under which it can live best and reproduce.

All the free-living organism are adapted to definite environmental conditions. Like-wise all the parasites too are adapted to their particular environment. In the latter case, the host species constitute the environment for the parasites which is different from the free-living environment. The host reacts to the presence of the parasite through its defense mechanism. So, only those parasites can live in a particular host which possess not only the morphological and physiological adaptability but also have the ability to overcome the defense mechanisms of the host.

It has been reported that certain species of nematodes require interacting factors, e.g., body temperature and effect of digestive enzymes, etc. for their development and that the required combinations may occur in the specific hosts. When the parasite finds in the hosts conditions suitable for its existence, formation of host-parasite system or relationship becomes possible.

In the present study, we did not find any nematode parasite infecting two hosts. However, incidence of infection by a single species of nematode in two different host may occur due to the following factors:

a) Either the hosts have almost identical physiological conditions

b) Or, like every creature parasites can also develop in different conditions to some extent from the optimum conditions of their existence.

The range of possible deflection from optimum conditions differs from species to species of the parasites.

Therefore, the more a parasite has the capacity to develop under varied environmental conditions, the more host it will infect.

Nematodes which have one host species may also therefore be capable of existence in other hosts. On the other hand, there is occurrence of more than one species of the same or different genera living side by side.

List of nematode parasites found infesting insect hosts

Host	**Nematode parasite described**
Class : Insecta	
Family: Gryllidae	
Genus: *Gryllotalpa*	
Species: *G. africana*	
	1. *Binema mirzaia* Basir,1942
	2. *Binema korsakowi* Sergiev,1923
	3. *Binema anulinervus* n.sp.
	4. *Binema ornata* Travassos,1925
	5. *Cameronia manipurensis* n.sp.
	6. *Cameronia triovata* n.sp.
	7. *Chitwoodiella ovofilamenta* Basir,1948
	8. *Gryllophila skrjabini* Sergiev, 1923
	9. *Mirzaiella asiatica* Basir,1942
Class: Insecta	
Family: Blattidae	
Genus: *Periplaneta*	
Species: *P. americana*	
	1. *Hammerschmidtiella diesingi* Hammerschmidt, 1838
	2. *Leidynema appendiculatum* Leidy, 1850
	3. *Ptrotrellus shamimi* n.sp.
	4. *Thelastoma periplaneticola* Leibersperger,1960

Class: Insecta

Family : Hydrophilidae

Genus: *Hydrophilus*

Species: *H. triangularis*

1. *Pseudonymus basiri* n.sp.
2. *Zonothrix imphali* n.sp.

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